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Attitudes of secondary school students towards doing research and design activities

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ABSTRACT

Research and design activities are often employed in STEM (Science, Technology, Engineering & Mathematics) education. This study aims to examine students' attitudes towards doing research and design activities in secondary school, among two groups of students: (1) students that take the quite recently introduced Dutch subject O&O (research & design), in which students perform authentic research and design projects related to STEM disciplines; and (2) students that do not take O&O. The subject O&O is only taught at a limited number of certified, so called 'Technasium', schools. A questionnaire, developed by the authors, was completed by 1625 students from Grades 8 and 11. Unlike previous studies on student attitudes, which usually use abstract concepts like 'science' or 'technology', the questionnaire used in this study contains active verbs to characterise research and design activities. The results showed that, in general, students who took the subject O&O had more positive attitudes towards doing research and design activities than regular students. Both student groups appeared to find doing design activities more enjoyable than doing research activities. The results of this study provide useful information for teachers as well as teacher educators about the existing attitudes of students, for example their preference for design projects over research projects.[1]

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Introduction

Teaching and learning about research and design have become important focus points in international science curricula (NGSS, 2013; NRC, 2012). Learning to conduct research and design activities can increase student knowledge, skills and awareness about science and engineering practices, enhancing their worldview on possible future professions as well as understanding the development of science and the links between research and design (NRC, 2012).

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In this study, student attitudes towards doing research and design activities are investigated, instead of students' attitudes towards science in general, which has already often been the focus of previous research (Osborne, Simon, & Collins, 2003). For instance, these studies have shown that students perceive the science domain as irrelevant, boring, too hard, and disconnected from the 'real world' (Aschbacher, Li, & Roth, 2010; Barmby, Kind, & Jones, 2008; Lyons, 2006; Potvin & Hasni, 2014). It has even been reported that students might view high-level science as one of the most useless things they learn in school (Kadlec, Friedman, & Ott, 2007). When using the active verb 'engineering', students' attitudes have been found to be fairly positive (Ara, Chunawala, & Natarajan, 2011). One's attitude informs one's behavioural intention, and consequently, can positively or negatively influence one's behaviour (Ajzen & Fishbein, 2005), for example, making a certain career or study choice.

Usually, research and design projects are embedded in traditional science subjects as short-term projects. A rather unique initiative is the relatively new course O&O (Dutch abbreviation for 'onderzoeken en ontwerpen', that is, 'research and design') in The Netherlands. This subject consists of research and design projects in STEM fields, and is taught 4–6 h a week to all grades in secondary education at so-called Technasium schools. O&O includes different fields of STEM (such as industrial engineering, ecology, etc.), is entirely project-based and student-centered, and focuses on authentic research and design tasks which are negotiated by real local companies and carried out in groups of students. The subject O&O provides an interesting and rather unique case in which students are continuously involved in research and design projects in STEM throughout their secondary school education. This provides us with the opportunity to determine whether students who take a subject completely dedicated to research and design projects in STEM have different attitudes than students who do not take this subject.

Research questions

With this research, we aim to answer the following questions:

(1) What are the attitudes of secondary school students towards doing research and design activities in general?
(2) Are there differences in student attitudes between doing research activities and doing design activities?
(3) Are there differences in attitudes between students taking the subject O&O and students who do not take this subject?
(4) Are there differences in student attitudes between lower (8th Grade) and upper (11th Grade) grades in secondary school, as attitudes have been known to decline when students proceed in secondary school (Barmby et al., 2008)?
(5) Are there differences in student attitudes between boys and girls, as technology and science related careers are still more often pursued by men than by women (Corbett & Hill, 2015; Van Langen & Dekkers, 2005)?

Theoretical framework

Characteristics of research and design activities

Research and design often go hand in hand, yet can still be seen as two separate practices with separate goals and histories (Williams, Eames, Hume, & Lockley, 2012). Research is often employed to explain, explore or compare certain situations by collecting and analysing data (Creswell, 2008). Design activities are used for developing or improving products or services (De Vries, 2005). Research and design have in common that they both are concerned with challenging, ill-structured problems or questions (Hathcock, Dickerson, Eckhoff, & Katsioloudis, 2015), and both are iterative practices. While many models are described in literature (for example see Kolodner, Gray, & Fasse, 2003; Willison & O'Regan, 2008), the research process generally consists of these phases: orientation on research question; generate hypotheses; plan research; collect data; organise and analyze data; conclude and discuss; communicate and present. The design process too can be captured in different models (Kolodner et al., 2003; Mehalik, Doppelt, & Schuun, 2008), however, it generally consists of the following phases: clarify problem; assemble programme of requirements; plan design; construct prototype; test prototype; repeat steps to optimise prototype; analyze product; communicate and present. Teachers often employ versions of these models when their students conduct research or design projects.

In educational policy documents like the NRC Framework (2012) and NGSS (2013), research and design activities are mentioned as important focal points in K-12 science and engineering education. These research and design practices are described as (1) Asking questions (for science) and defining problems (for engineering); (2) Developing and using models; (3) Planning and carrying out investigations; (4) Analyzing and interpreting data; (5) Using mathematics and computational thinking; (6) Constructing explanations (for science) and designing solutions (for engineering); (7) Engaging in argument from evidence; (8) Obtaining, evaluating, and communicating information (NRC Framework 2012). It is noteworthy that in this summary, science and engineering practices do not have their own separate process descriptions but have similar phases. However, the authors distinguish between science and engineering as two different practices with different goals: answering questions for science, and solving problems for engineering. The objectives for research and design activities in NRC (2012) and NGSS (2013) are similar to the learning goals of the subject O&O, which forms the context of our study.

Context: research and design in the Netherlands

The subject O&O was introduced in The Netherlands in 2004 and is taught at so-called Technasium certified schools. In September 2017, there are 92 certified Technasium schools in The Netherlands. Local companies usually act as 'clients' for projects, providing students with real research and design problems. For example, in one project a local company asked students to optimise an algae reactor, with a list of factors that influence algae growth, and a plan for upscaling the company's reactor. At the start of 8th Grade, students will have actively decided whether or not to follow the subject O&O. In some schools, this decision is already made at the start of Grade 7. After this decision, students follow the subject up to 9th Grade, after which they make a choice for a so-called Nature-profile or a Society-profile. Students with a Nature profile often choose O&O as an elective (and in some schools, this is mandatory), but sometimes Society-profile students can choose O&O as well. This means that in 11th Grade, some students have chosen to follow O&O themselves, and some students are obliged to take the subject (this depends on individual school rules). Then, they take this subject until they graduate. An O&O teacher acts as a coach rather than a content specialist, and helps students to develop skills like planning, teamwork and perseverance. The main aims of O&O are (1) to acquaint students with STEM professions, and (2) to let students handle up-to-date and authentic STEM questions, in order to stimulate them to develop skills as competent researchers and designers (SLO, 2014).

O&O is a STEM course that uses different teaching approaches than traditional science subjects and has not yet been extensively researched. As O&O only consists of authentic projects and students can take this subject for multiple years, the subject thus provides students with repeated authentic learning experiences. The format of the subject O&O is unique, but the project based nature of the subject and the focus on research and design activities can also be found in other STEM projects or subjects around the world. Therefore, O&O forms an interesting context to study whether students taking this subject hold different attitudes towards doing research and design tasks.

Attitudes towards doing research and design activities

In this paper we focus on students' attitudes towards doing research and design activities. Attitude includes one's knowledge, values, feelings, motivation and self-esteem shaping an individual's personal outlook on a certain subject (Kind, Jones, & Barmby, 2007; Van Aalderen-Smeets, Walma van der Molen, & Asma, 2012) and can be described within three components: a cognitive, an affective and a behavioural component (Eagly & Chaiken, 1993). For example, one's attitude towards science includes: one's knowledge about what science actually involves (cognition), how one feels about science (affect), and how one would be willing to display certain behaviour towards science (for example: taking a science course, or becoming a member of a science club).

Van Aalderen-Smeets et al. (2012) constructed a framework to define attitude towards science in the context of primary school teachers. They adapted the traditional, tripartite model of attitude (Eagly & Chaiken, 1993) and added a new main category: that of perceived control, with subcategories self-efficacy and context dependency (Figure 1). Their review of existing studies on attitude showed that, apart from cognition, affect and behaviour, the belief that one can succeed in doing a particular task (self-efficacy; Bandura, 1997) and the influence of context factors such as availability of teaching material and time (context dependency) also played a role in the construction of teachers' attitudes towards teaching science.

In this study, we use the attitude model of Van Aalderen-Smeets et al. (2012) in the context of secondary school students' attitudes towards doing research and design activities. This model fitted the goals of our study, because of the inclusion of one's self-efficacy in this model. Previous research on the subject of mathematics has shown that students' self-efficacy influences their attitude (Marchis, 2011). Self-efficacy is the belief that one can succeed in doing a particular task (Bandura, 1997). It has been shown that self-efficacy can be an important mediator in career choice (Pajares, 1997); students with a low self-efficacy regarding a subject will be less likely to pursue courses or a career related to this subject.

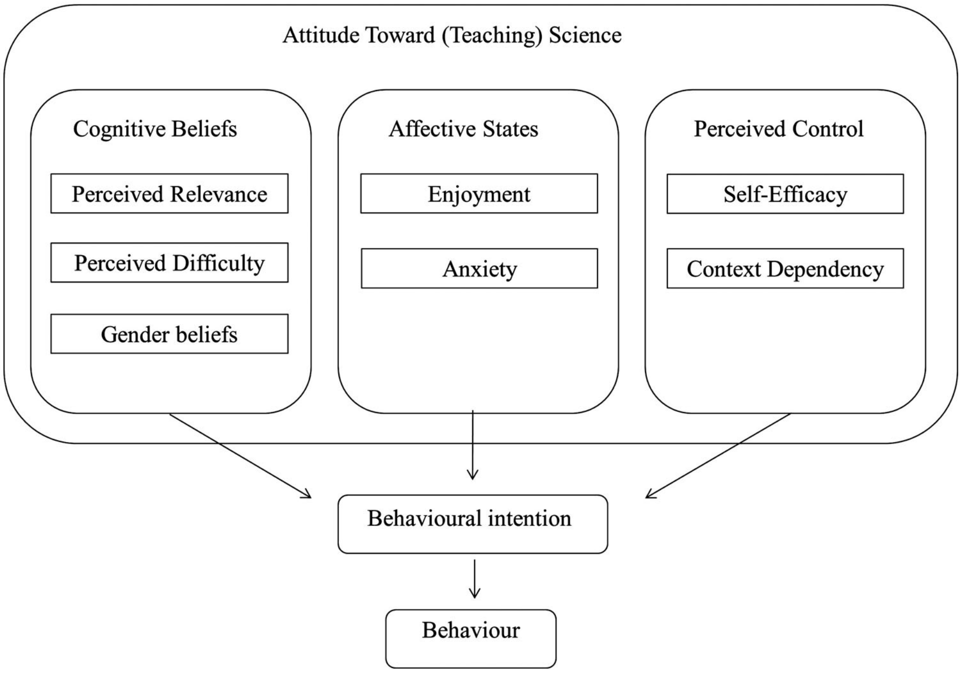

Figure 1. Theoretical framework for attitude toward (teaching) science. Adopted from Van Aalderen-Smeets, Walma van der Molen and Asma (2012, p. 176).

High self-efficacy has also been related to higher academic achievement (Pajares & Schunk, 2001). Inquiry based contexts in science have been shown to act as a possible catalyst for students' self-efficacy (Ketelhut, 2007). Apart from one's self-efficacy, the cognitive and affective component of the attitude model can also influence student career or study choices. For example perceived difficulty, the subcategory that refers to the beliefs of students regarding the general difficulty of a subject (in our case, doing research or design activities), has been shown to be a predictor to most behavioural intentions and behaviour (Trafimow, Sheeran, Conner, & Finlay, 2002), and therefore has a major influence on students' subject choice (Havard, 1996).

Previous studies have often focused on students' attitudes towards science and technology in general, rather than on doing research and design activities. These studies showed that students' attitudes towards science tend to become more negative during secondary school (Barmby et al., 2008; Crawford, 2014; Potvin & Hasni, 2014). A similar trend was found for students' attitudes towards technology – these declined from the first to the second year of secondary school, despite some students taking additional hours in the subject technology (Ardies, De Maeyer, Gijbels, & van Keulen, 2015). Another study found that technology-oriented company visits for primary school children also did not lead to an increased positive attitude towards technology (Post & Walma van der Molen, 2014). Students' attitudes towards design and engineering on the other hand, tend to be fairly positive (Ara et al., 2011; Kőycű & Vries, 2016). This could indicate that students hold different attitudes towards the abstract topics of technology or science, compared to doing technology or science related activities (like engineering and doing research). Thus, our study aims to elicit students' attitudes towards doing research and design activities, using a questionnaire applying active formulation by using verbs (like 'conducting a design', 'doing a research project', 'engineering', etc.), rather than using the abstract, passive nouns 'science' and 'technology'. For an overview of the detailed research aims, please see the last paragraph of the Introduction.

Methods

Participants

Students from secondary schools from 8th Grade (ages 13–14) and from 11th Grade (ages 16–17) participated in our study, so we could compare student attitudes in lower and upper secondary education. For this purpose, teachers of several Technasium schools (randomly selected from a list of schools available on the Technasium website) and regular schools were approached by email. The questionnaires were distributed as hardcopies by post, to be received by the teacher who acted as our contact person. Passive informed consent was obtained from the teachers of the students, and students themselves were informed via an instruction letter. The authors had no influence on the selection of students; as the partaking in this study was voluntarily, the teachers themselves selected the 8th or 11th grade classes that participated. Ethical approval was obtained from the ethics committee of Leiden University Graduate School of Teaching. For this study, 1315 questionnaires were sent to 22 Technasium schools offering the subject O&O, and 1164 questionnaires to the 16 schools without the subject O&O. In total, 1864 questionnaires were returned from 34 schools (22 Technasium schools and 12 regular schools), a response rate of 75%. The schools were situated all over The Netherlands, although the spread of Technasium schools over different provinces was greater. This was due to the fact that at the moment of this study, a limited number of Technasium schools taught the subject O&O at 11th Grade level. Therefore, we had to approach more schools to get a better sample of this group of students. Information on demography or curricular orientations of the schools was not collected. The aim was to compare O&O schools to non-O&O schools in general, and therefore our main criterion to select regular schools was that they did not offer O&O (other curricular activities were thus not taken into account). All students who did not take the subject O&O came from the regular schools that did not offer O&O as a subject.

After manually excluding questionnaires that were accidentally filled in by grades other than Grades 8 and 11 and questionnaires that were filled in without serious intention, 1788 questionnaires remained. These were scanned into the computer and further examined in an SPSS file. We decided to include partly incomplete questionnaires, because most students only left relatively few items unanswered. As a consequence, analyses were based on slightly different numbers of individual questionnaires, as students incidentally left a few items unanswered in the questionnaire. Students with missing grade were excluded ($n = 10$), as well as 11th Grade students that were not enrolled in the Nature profiles we selected for in our research ($n = 18$). Some 8th Graders were excluded due to inconsistency ($n = 93$): they stated they took a specific science subject that is officially only taught in higher secondary education (from 10th Grade and up). Students that did not indicate whether or not they (had) taken the subject O&O, were also excluded ($n = 42$). In total, 1625 students were included in further analyses. Table 1 shows the number of boys and

Table 1. Basic characteristics of participants.

Categories		Total (*n*)	O&O students (*n*)	Non-O&O students (*n*)
Number of students		1625	924	701
Gender	Boy	947	589	358
	Girl	672	330	342
	Missing	6	5	1
Grade	8th Grade	945	608	337
	11th Grade	680	316	364
Age mean (sd)	8th Grade	13.18 (0.60)	13.16 (0.63)	13.21 (0.54)
	n (missing)	943 (2)	608 (0)	335 (2)
	11th Grade	16.36 (0.75)	16.27 (0.76)	16.44 (0.73)
	n (missing)	680 (0)	316 (0)	364 (0)

girls in the sample population, the number of students per grade level and the mean age of the students per grade level.

Design of the questionnaire

To construct our Attitudes towards Doing Research And Design Activities (ADRADA) questionnaire, we used the framework for attitudes towards (teaching) science (by Van Aalderen-Smeets et al., 2012; see Figure 1). Van Aalderen-Smeets and Walma van der Molen (2013) developed their own questionnaire based on this theoretical model: the Dimensions of Attitude towards Science (DAS) questionnaire, which they used in the context of elementary school teachers teaching science. We adapted the items of DAS to the context of students in secondary school, and their attitudes towards doing research and design activities, instead of science.

The DAS consists of seven subcategories: Relevance, Difficulty, Gender, Enjoyment, Anxiety, Self-Efficacy and Context Dependency. We used all subcategories except for Gender. Items in the Gender subcategory were focused on whether students think researching or designing are activities more suited for boys than girls (or vice versa). Our fifth research question focusses on differences in attitude between boys and girls, and not on if they think research or design activities are more suitable for boys. We thus excluded this subcategory as it was not among our main interests. We also included items on intended behaviour, regarding the future of the students (e.g. choice of study or occupation), to explore whether students attitudes coincide with certain behavioural intentions. These items were not adapted from DAS, but from another questionnaire on student attitudes by Post and Walma van der Molen (2014). Items were scored on a 1–5 Likert scale, where 1 = strongly disagree and 5 = strongly agree. The complete ADRADA questionnaire was constructed in Dutch and is available upon request.

Analyses

We determined the internal consistency for all subcategories in the attitude scales by calculating Cronbach's alpha (α) (Table 2). Because we decided to include questionnaires with incidental missing items, calculations for each category were based on a different number of individual questionnaires. Problematic items that lowered the Cronbach's

Table 2. Cronbach's alpha for the scales for student attitudes towards doing research and design activities.

			Design				
Main category	Sub category	Number of items	α	M	SD	SE	Number of students
Cognition	Relevance	4	0.72	3.65	2.70	0.07	1415
	Difficulty	3	0.75	3.16	2.22	0.06	1324
Affection	Enjoyment	3	0.82	3.10	2.60	0.07	1521
	Anxiety	4	0.68	2.45	2.74	0.07	1413
Perceived Control	Self-efficacy	4	0.64	3.27	2.52	0.07	1430
	Context dependency	3	0.59	3.34	2.20	0.06	1511
Behaviour	Future	3	0.83	2.98	2.92	0.08	1422
Average			0.72				
			Research				
Main category	Sub category	Number of items	α	M	SD	SE	Number of students
Cognition	Relevance	4	0.76	3.36	2.94	0.08	1371
	Difficulty	3	0.76	2.94	2.22	0.06	1345
Affection	Enjoyment	3	0.86	3.47	2.81	0.07	1480
	Anxiety	4	0.74	2.32	2.84	0.07	1484
Perceived Control	Self-efficacy	4	0.74	3.48	2.69	0.07	1429
	Context dependency	3	0.63	3.39	2.18	0.06	1472
Behaviour	Future	3	0.90	3.24	3.16	0.08	1444
Average			0.77				

Notes: Total number of students was $n = 1625$. α = Cronbach's alpha, M = mean, SD = standard deviation, SE = standard error. Note that due to the algorithm for Cronbach's alpha, all students with missing values were excluded from the analysis of each subcategory (unlike our forthcoming analyses, where we do include students with missing values).

alpha were removed from further analyses. The final ADRADA questionnaire therefore consisted of 57 items: 24 items on attitude towards doing research activities, 24 items on attitudes towards doing design activities, and 9 items on personal variables. Most subcategories showed satisfactory reliability of 0.7 or higher, even though the scales were based on small numbers of items. Subcategories with a Cronbach's alpha lower than 0.7 (Anxiety, Self-efficacy and Context Dependency in the research component of the questionnaire, and Context Dependency in the design component of the questionnaire) were still included in further analyses for continuity, as we aimed to explore the data according to the theoretical model of seven subcategories. However, since their internal consistency was not ideal, we approached differences on these dimensions and implications based thereon with caution.

We used Exploratory Factor Analyses to examine whether the questionnaire items sufficiently clustered according to the intended seven subcategories in the ADRADA: Difficulty, Relevance, Anxiety, Enjoyment, Self-efficacy, Context dependency and Future. Principal Component Analysis (PCA) with a Varimax rotation for both the research and design components of the ADRADA showed that the items indeed clustered within 7 categories (see Appendix). However, two negatively formulated items of Anxiety clustered together, while two positively (reversely) formulated items of Anxiety clustered along with the items of Enjoyment. We suspect this happened because of the reverse formulation of the items. To further assess the generalizability of the factors of the intended model, we also used a Confirmatory Factor Analysis on the items of the research component of the ADRADA, to illustrate the fit of the model onto the component with the most problematic subcategories according to the Cronbach's alpha scores. We used robust standard errors through clustering to account for the multilevel structure of the data, as students were nested within schools, subject conditions (O&O versus non-O&O), and within the two Grade levels. These analyses showed a reasonable to good fit in the research component of the ADRADA in the seven subcategories. Further suggestions for model stability are derived from the exploratory component analysis, which yields minimal deviations from the theoretical model, with only slightly higher fit when assessed through CFA. As the design components of the ADRADA showed higher scores on internal consistency compared to research, we expect similar or even better results for this component. The PCA and CFA analyses thus indicate that we can keep the subcategories as described in the theoretical model, and remain consistent with literature and with the original intentions of the ADRADA.

Multilevel analyses for all subcategories in de ADRADA questionnaire were applied to the data to determine any differences between groups. Differences between students taking O&O and students not taking O&O were calculated, as well as differences between 8th and 11th Grade, and differences between boys and girls. A paired samples t-test was used to determine whether any difference existed between the attitudes towards doing research activities and the attitudes towards doing design activities. All analyses were performed with IBM SPSS Statistics version 22.

Results

The subheadings in this section correspond to the research questions of this study. A detailed overview of all aims and research questions was mentioned in the last paragraph of the Introduction.

General attitude towards doing research and design activities

In the research component of the ADRADA questionnaire, students scored highest on the 1–5 Likert scale on items in the subcategories Relevance, Context and Self-efficacy (Table 3). This means students see doing research as a relevant activity to learn at school, and they find themselves reasonably capable to complete such tasks. The lowest scoring subcategories were Anxiety, indicating students do not feel all that anxious when performing a research task, and Future, which indicates students are not overly enthusiastic to continue in a research career.

Table 3. General attitude towards doing research and design activities.

		Research			Design		
Main category	Sub category	Mean	SD	*N*	Mean	SD	*N*
Cognition	Relevance	3.62	0.70	1611	3.32	0.75	1574
	Difficulty	3.14	0.75	1542	2.93	0.74	1496
Affection	Enjoyment	3.10	0.87	1606	3.45	0.94	1588
	Anxiety	2.48	0.70	1608	2.34	0.72	1571
Control	Self-efficacy	3.25	0.65	1613	3.46	0.68	1580
	Context	3.33	0.74	1607	3.37	0.74	1585
Behaviour	Future	2.97	0.98	1567	3.22	1.05	1551

Notes: Total $n = 1625$, however due to incidental missings n is different for every category, varying between 1496 and 1613.

For attitudes towards doing design activities, students scored highest on the subcategories Self-efficacy and Enjoyment (Table 3) on the 1–5 Likert scale. This indicates students enjoy doing design projects and find themselves capable to carry out design projects. The lowest scoring subcategories are Anxiety and Difficulty, meaning students do not find design tasks that hard to do and are not so anxious while doing them.

When calculating the differences between the students' general attitude towards doing research activities and their attitude towards doing design activities, all categories differ significantly ($p = 0.000$). In general, students had a significantly more positive attitude towards doing design activities than towards doing research activities, and experienced less anxiety and difficulty when performing design tasks. However, on the subcategory Relevance, students on average scored significantly higher on Relevance of doing research activities.

Difference between O&O and non-O&O students

Students taking the subject O&O in Technasium schools scored significantly higher on the subcategories Relevance of doing research activities, Self-efficacy when performing research projects and Context that enables them to do research, than students who did not attend Technasium schools and who did not follow the O&O course (Table 4). O&O students furthermore showed significantly less anxiety towards doing research tasks than non-O&O students. When we look at the attitudes towards design, all categories differ significantly from each other (Table 4). O&O students generally had a more positive attitude towards design, experienced less anxiety and found designing less difficult to do. Students following the subject O&O scored highest on the subcategories Enjoyment (mean = 3.66, SD = 0.87) and Self-efficacy (mean = 3.61, SD = 0.64), with scores over 3.5 on a 5-point Likert scale.

In the last two columns of Table 4, we calculated the differences between the students' attitudes towards doing research activities and their attitudes towards doing design activities within the O&O group and the non-O&O group. This shows that students who followed the subject O&O had a significantly more positive attitude towards doing design activities than towards doing research activities, except on the subcategory Relevance (Table 4). Students who did not follow the O&O subject also seemed to have a significantly more positive attitude towards design, except on the subcategories Relevance and Future (Table 4). Non-O&O students, like O&O students, scored items on Relevance of doing research activities higher than Relevance of doing design activities. However, students who did not follow O&O scored significantly higher on future choices related to research in their studies or careers, as opposed to O&O students, who scored significantly higher on items related to future choices in design related studies or careers.

Difference between lower and upper secondary education

When we look at the complete group of participating students, 945 students were in lower secondary education (Grade 8) and 680 students were in upper secondary education (Grade 11). Students in the 11th Grade scored significantly higher ($p = 0.001$) on difficulty of doing research activities (mean = 3.21, SD = 0.71, $n = 661$) than students in

Table 4. Differences between students who follow the subject O&O and students who do not in attitudes towards doing research and design activities, and differences between attitudes towards doing research and design activities within both student groups.

		Differences between O&O and non-O&O students' attitudes towards doing research activities					Differences between O&O and non-O&O students' attitudes towards doing design activities					Differences between attitudes towards research and design	
		O&O students ($n_{tot} = 924$)		Non-O&O students ($n_{tot} = 701$)			O&O students ($n_{tot} = 924$)		Non-O&O students ($n_{tot} = 701$)			Within O&O students	Within non-O&O students
Main category	Sub category	Mean	SD	Mean	SD	Sign. *p*	Mean	SD	Mean	SD	Sign. *p*	*p*	*p*
Cognition	Relevance	3.67	0.71	3.56	0.68	**0.001**	3.44	0.73	3.17	0.74	**0.000**	**0.000**	**0.000**
	Difficulty	3.15	0.73	3.13	0.77	0.645	2.88	0.75	3.00	0.72	**0.004**	**0.000**	**0.000**
Affection	Enjoyment	3.07	0.88	3.14	0.86	0.092	3.66	0.87	3.18	0.95	**0.000**	**0.000**	**0.000**
	Anxiety	2.44	0.67	2.53	0.75	**0.009**	2.24	0.68	2.47	0.75	**0.000**	**0.000**	**0.000**
Control	Self-efficacy	3.35	0.63	3.12	0.65	**0.000**	3.61	0.64	3.26	0.68	**0.000**	**0.000**	**0.000**
	Context	3.42	0.73	3.22	0.74	**0.000**	3.48	0.73	3.22	0.74	**0.000**	**0.000**	**0.000**
Behaviour	Future	2.97	0.96	2.97	1.00	0.966	3.46	0.98	2.92	1.06	**0.000**	**0.000**	**0.000**

Notes: For O&O students, total $n = 924$, and for non O&O students, total $n = 701$, however due to incidental missings *n* is different for every category or comparison. Significant p-values are indicated in **bold**.

the 8th Grade (mean = 3.09, SD = 0.77, $n = 881$). Students in 11th Grade scored significantly lower ($p < 0.001$) on items within the component of Context – factors enabling them to do research activities at school (such as sufficient time and materials). Also, students in upper secondary education scored higher ($p < 0.001$) on future aspirations regarding doing research (mean = 3.09, SD = 0.95, $n = 665$). In students' attitudes towards doing design activities, significant differences between Grade levels were present in the subcategories Enjoyment ($p = 0.024$) and Context ($p < 0.001$). Students in lower secondary education scored higher on the Enjoyment component (mean = 3.50, SD = 0.94, $n = 925$) than 11th Grade students (mean = 3.39, SD = 0.93, $n = 63$) and the lower grade students also scored higher on enabling context factors when designing in class (mean = 3.46, SD = 0.73, $n = 926$).

When we split up the complete group of students in O&O and non-O&O students again, we see some differences between lower and upper secondary education in the O&O group versus lower and upper secondary education in the non-O&O group. O&O students in upper secondary education scored significantly higher on items in the Self-efficacy component for both doing research and design activities than students in lower secondary education, unlike students who did not follow the O&O course (Tables 5 and 6). In both groups of students (O&O and non-O&O), 11th graders scored higher

Table 5. Differences in attitudes towards doing research activities between 8th and 11th Grade in O&O and non-O&O students.

		O&O students					Non-O&O students				
		8th Grade ($n_{tot} = 608$)		11th Grade ($n_{tot} = 316$)			8th Grade ($n_{tot} = 337$)		11th Grade ($n_{tot} = 364$)		
Main category	Sub category	Mean	SD	Mean	SD	Sign. p	Mean	SD	Mean	SD	Sign. p
Cognition	Relevance	3.65	0.73	3.73	0.66	0.090	3.48	0.72	3.63	0.63	**0.004**
	Difficulty	3.11	0.75	3.22	0.69	**0.042**	3.04	0.82	3.21	0.72	**0.005**
Affection	Enjoyment	3.07	0.91	3.05	0.83	0.745	3.18	0.88	3.10	0.84	0.283
	Anxiety	2.46	0.70	2.39	0.62	0.143	2.43	0.74	2.62	0.74	**0.000**
Control	Self-efficacy	3.29	0.65	3.46	0.57	**0.000**	3.10	0.66	3.13	0.63	0.578
	Context	3.47	0.74	3.30	0.70	**0.001**	3.29	0.75	3.15	0.73	**0.013**
Behaviour	Future	2.95	0.97	3.01	0.94	0.336	2.78	1.00	3.15	0.96	**0.000**

Notes: The actual number of students included per category can differ slightly from n_{tot} due to incidental missings in the data. Significant p-values are indicated in **bold**.

Table 6. Differences in attitudes towards doing design activities between 8th and 11th Grade in O&O and non-O&O students.

		O&O students					Non-O&O students				
		8th Grade ($n_{tot} = 608$)		11th Grade ($n_{tot} = 316$)			8th Grade ($n_{tot} = 337$)		11th Grade ($n_{tot} = 364$)		
Main category	Sub category	Mean	SD	Mean	SD	Sign. p	Mean	SD	Mean	SD	Sign. p
Cognition	Relevance	3.42	0.74	3.47	0.71	0.285	3.13	0.75	3.20	0.74	0.239
	Difficulty	2.90	0.77	2.86	0.72	0.531	2.94	0.71	3.04	0.72	0.072
Affection	Enjoyment	3.63	0.90	3.72	0.81	0.126	3.26	0.96	3.10	0.93	**0.031**
	Anxiety	2.26	0.70	2.20	0.65	0.201	2.40	0.74	2.53	0.75	**0.025**
Control	Self-efficacy	3.58	0.66	3.67	0.61	**0.043**	3.30	0.73	3.22	0.64	0.157
	Context	3.51	0.75	3.44	0.68	0.166	3.37	0.70	3.08	0.75	**0.000**
Behaviour	Future	3.43	1.00	3.50	0.95	0.365	2.89	1.07	2.94	1.05	0.577

Notes: The actual number of students included per category can differ slightly from n_{tot} due to incidental missings in the data. Significant p-values are indicated in **bold**.

on the subcategory Difficulty of doing research activities, and lower on the Context component of doing research activities than 8th graders. Furthermore, in the non-O&O group, students in upper secondary education scored significantly higher on the subcategories Relevance of doing research activities and Future intentions to pursue in a research related study or career, unlike the O&O group. Also unlike the O&O group, upper secondary students of the non-O&O group scored higher on the Anxiety component than students in the lower secondary grade. In the non-O&O group, 11th graders scored significantly higher on Anxiety towards designing, and lower on the components Enjoyment and Context. It would seem that regular students' anxiety towards doing research and design activities increases from 8th to 11th Grade, while in students following O&O, this is not the case.

Difference between boys and girls

In the complete group of participating students, 947 boys filled in the questionnaire, and 672 girls. When looking at all boys and girls in general, we see that in both attitude towards doing research activities and attitude towards doing design activities, boys scored items within the main category Control (Self-efficacy and Context) significantly higher than girls (Table 7). Girls scored significantly higher on the Anxiety component in attitude towards doing research activities, and significantly lower on items in the components Relevance and Future of doing design activities.

When we split up this complete group of students in an O&O and a non-O&O group again (Table 8), we see some differences. In both O&O and non-O&O students, boys scored significantly higher on the subcategory Self-efficacy of doing research activities, and also on the main category of Control within attitude towards doing design activities. Girls within the non-O&O group scored significantly higher on Anxiety and Difficulty in doing research activities than boys. When calculating the differences between the students' attitudes towards doing research activities and their attitudes towards doing design activities (see the last two columns in Table 8), we see that students who took the subject O&O, both boys and girls, had a significantly more positive attitude towards doing design activities than towards doing research activities, except on the subcategory Relevance. Students who did not follow the

Table 7. Attitudes towards doing research and design activities: differences between boys and girls in general.

		Research					Design				
		Boys (n_{tot} = 947)		Girls (n_{tot} = 672)		Sign.	Boys (n_{tot} = 947)		Girls (n_{tot} = 672)		Sign.
Main category	Sub category	Mean	SD	Mean	SD	*p*	Mean	SD	Mean	SD	*p*
Cognition	Relevance	3.62	0.70	3.63	0.68	0.833	3.36	0.74	3.28	0.74	**0.030**
	Difficulty	3.11	0.74	3.18	0.76	0.079	2.93	0.76	2.94	0.70	0.757
Affection	Enjoyment	3.11	0.88	3.09	0.86	0.657	3.45	0.92	3.45	0.96	0.939
	Anxiety	2.43	0.69	2.54	0.72	**0.002**	2.32	0.72	2.36	0.72	0.264
Control	Self-efficacy	3.35	0.62	3.11	0.65	**0.000**	3.53	0.66	3.37	0.69	**0.000**
	Context	3.37	0.76	3.28	0.71	**0.014**	3.43	0.75	3.29	0.73	**0.000**
Behaviour	Future	3.00	0.96	2.93	1.01	0.136	3.28	1.03	3.14	1.07	**0.010**

Notes: The actual number of students included per category can differ slightly from n_{tot} due to incidental missings in the data. Significant p-values are indicated in **bold**.

Table 8. Attitudes towards doing research and design activities: differences between boys and girls within the O&O and non-O&O student groups, and differences between the attitudes towards doing research and design activities within boys and girls.

		Non-O&O students											
		Research					Design					Differences between attitudes towards research and design	
		Boys ($n_{tot} = 358$)		Girls ($n_{tot} = 342$)		Sign.	Boys ($n_{tot} = 358$)		Girls ($n_{tot} = 342$)		Sign.	Within boys	Within girls
Main category	Sub category	Mean	SD	Mean	SD	*p*	Mean	SD	Mean	SD	*p*	*p*	*p*
Cognition	Relevance	3.56	0.68	3.56	0.67	0.952	3.18	0.73	3.16	0.76	0.698	**0.000**	**0.000**
	Difficulty	3.07	0.76	3.20	0.78	**0.025**	2.95	0.74	3.04	0.69	0.085	**0.000**	**0.000**
Affection	Enjoyment	3.17	0.85	3.11	0.87	0.341	3.14	0.93	3.21	0.97	0.349	**0.000**	**0.000**
	Anxiety	2.42	0.72	2.64	0.75	**0.000**	2.44	0.76	2.49	0.74	0.430	**0.000**	**0.000**
Control	Self-efficacy	3.24	0.63	3.00	0.64	**0.000**	3.31	0.68	3.20	0.68	**0.030**	**0.000**	**0.000**
	Context	3.24	0.77	3.20	0.71	0.475	3.28	0.76	3.16	0.71	**0.043**	**0.000**	**0.000**
Behaviour	Future	3.02	0.98	2.91	1.02	0.152	2.93	1.03	2.90	1.09	0.725	**0.000**	0.232

		O&O students											
		Research					Design					Differences between attitudes towards research and design	
		Boys ($n_{tot} = 589$)		Girls ($n_{tot} = 330$)		Sign.	Boys ($n_{tot} = 589$)		Girls ($n_{tot} = 330$)		Sign.	Within boys	Within girls
Main category	Sub category	Mean	SD	Mean	SD	*p*	Mean	SD	Mean	SD	*p*	*p*	*p*
Cognition	Relevance	3.66	0.71	3.70	0.69	0.404	3.47	0.28	3.40	0.73	0.196	**0.000**	**0.000**
	Difficulty	3.14	0.72	3.16	0.74	0.683	2.91	0.77	2.83	0.70	0.102	**0.000**	**0.000**
Affection	Enjoyment	3.07	0.89	3.06	0.86	0.946	3.64	0.87	3.70	0.89	0.327	**0.001**	**0.000**
	Anxiety	2.44	0.67	2.43	0.66	0.893	2.25	0.69	2.23	0.67	0.688	**0.000**	**0.000**
Control	Self-efficacy	3.42	0.61	3.23	0.64	**0.000**	3.65	0.62	3.54	0.67	**0.009**	**0.000**	**0.000**
	Context	3.45	0.75	3.36	0.70	0.077	3.52	0.73	3.42	0.73	**0.040**	**0.000**	**0.000**
Behaviour	Future	2.99	0.94	2.94	1.00	0.478	3.49	0.97	3.40	1.00	0.156	**0.000**	**0.000**

Notes: The actual number of students included per category can differ slightly from n_{tot} due to incidental missings in the data. Significant p-values are indicated in **bold**.

O&O subject also seemed to have a significantly more positive attitude towards design compared to research, except on the subcategories Relevance and Future. In non-O&O students, there were no significant differences between future aspirations for research or design careers among girls. Boys who did not follow O&O however, scored significantly higher on items in the component concerning Future aspirations in research careers, as opposed to all other groups of students.

Conclusion & discussion

Like the Results section, the subheadings in this section correspond to the research questions of this study.

General attitudes of secondary school students towards doing research and design activities

On the basis of our results in respect to the first research question, we can conclude that students in secondary education had neutral to slightly positive attitudes towards doing research activities and somewhat more positive attitudes towards doing design activities, which on average, they viewed as less difficult and more enjoyable. Students viewed doing research activities as more relevant and important to know about than designing. The positive attitude found towards doing design activities is similar to findings on students' positive attitudes towards engineering (Ara et al., 2011; Kőycű & Vries, 2016), which is, like designing, another technology and science related activity. It should be noted, however, that while they have similar translations in Dutch, this may not be the case for all languages or cultures, and therefore designing and engineering cannot be regarded as exactly the same. It is also interesting to note that students found doing research activities more relevant or important than learning to do design activities, however they also found doing research activities more difficult and less enjoyable. A study of Kadlec et al. (2007) showed that students and their parents indeed acknowledged science as being important, while at the same time however they saw a disconnect between math, science and technology education and their personal lives. A possible explanation for why students find research projects less enjoyable, could be that students associate research (in science) with looking for answers that are already known by the teacher (Millar, 2004), while design activities could lead to unknown and new solutions. As our study only describes existing attitudes of students measured by a questionnaire, we have no qualitative data to explain why students considered design activities more enjoyable than research projects. A qualitative follow-up study could give more insight in the reasons why for example students found doing research less enjoyable than doing design tasks.

Differences between attitudes of students taking the subject O&O and students who do not take this course

Results of this study show that students taking the subject O&O had significantly more positive attitudes towards doing design activities than non-O&O students on all components, and on some components towards doing research activities. O&O students found doing research activities significantly more relevant than non-O&O students. They experienced less anxiety towards doing research tasks, and also scored significantly higher on positive self-efficacy and enabling context factors while doing research activities, although these results should be interpreted carefully as these scales had the lowest internal consistency in the ADRADA. Students taking the subject O&O also scored significantly higher on future aspirations to pursue a design related study or career than a career in research, whereas in the non-O&O group, students scored significantly higher on interest in a research related future occupation. This could be explained by the fact that only O&O students have extensive experiences with doing design activities in school and seem to find these more enjoyable than doing research, while doing research activities is common in both O&O and non-O&O classes. Follow-up studies could provide more information on whether O&O students actually choose STEM studies or occupations more often than regular students later in life.

A possible explanation for the differences in attitude between O&O and non-O&O students could also be the nature of the subject O&O, which is project- and context-based and uses inquiry, design and project based learning practices. A meta-analysis by Savelsbergh et al. (2016) showed that approaches such as Inquiry Based Learning (gaining knowledge through inquiry to solve a puzzling situation- Woolfolk, 2004) in science subjects indeed appear to have a positive influence on student attitudes. Other studies found that Problem Based Learning positively influenced students' attitudes (Lou, Shih, Diez, & Tseng, 2011; Tandogan & Orhan, 2007).

As O&O is mostly an elective subject, students who take O&O as a subject could already have more positive attitudes towards doing research and design projects, because they show interest by actually choosing O&O. We could not correct for this possible influence on students' attitudes. However, the strong significant differences between O&O and non-O&O students, even up in 11th Grade where all students have chosen Nature profiles and thus have shown their interest in science, strongly suggest that the subject O&O has the potential to influence students' attitudes. More research is needed to provide empirical evidence, for example though effect studies.

Differences between attitudes of students in lower and upper secondary education

Results on the third research question show that students in lower secondary education scored higher on context factors, this might suggest that they experienced sufficient time, recourses and help when conducting research and design projects. Students in the upper secondary grade scored higher on difficulty of doing research activities, meaning they find doing research projects more difficult than lower grade students. As students proceed in their education, school projects often indeed become more difficult and complicated in higher grades. Despite viewing research activities as more difficult, 11th Grade students scored higher on future aspirations to do something with research than 8th Grade students.

Students who took the subject O&O showed higher self-efficacy in 11th Grade than in 8th Grade. This may suggest students become more confident in their abilities to conduct research and design tasks as they progress in education. The increased self-efficacy of O&O students could possibly be attributed to more mastery experiences and chances to interpret previous performances, important factors in creating self-efficacy beliefs

(Britner & Pajares, 2006). Students who did not take the O&O course did not show this increase in self-efficacy from 8th to 11th Grade. In 11th Grade they even scored higher on the Anxiety components both towards doing research and design activities, suggesting that regular students' anxiety towards doing research and design tasks might increase from 8th to 11th Grade. The interpretation of these results is carefully formulated as the Self-efficacy and Anxiety scales showed lower internal consistency.

Differences between attitudes of boys and girls

In general, boys scored higher on the control component of attitude towards doing research and design activities, indicating that boys seem more confident and feel better enabled than girls to conduct research and design projects. Girls felt significantly more anxiety towards doing research activities than boys, and lower self-efficacy, although these results should be interpreted carefully as these scales showed lower internal consistency . Boys seemed to value design activities as more relevant and as a more interesting study or career path than girls, however, this difference is not found anymore when we look separately at students in the O&O group and students in the non-O&O group. These results contrast with findings of Britner and Pajares (2006), who found that girls scored higher on self-efficacy in science than boys. Jovanovic and King (1998), however, found that for girls, even after one year of hands-on performance-based science lessons, there was a decrease in science ability perceptions. Previous studies have shown that boys are more likely to be encouraged by teachers in participation in science than girls (AAUW, 1992; Sadker & Sadker, 1995). Sadker and Sadker (1995) argued that teachers might view boys as more difficult to handle and find it harder to keep their attention, hence making teachers try harder to keep them involved than girls. This teacher behaviour could result in making boys feel more confident in doing science than girls.

However, boys and girls in general did not differ on the subcategories Difficulty and Enjoyment, meaning both groups found research and design activities equally difficult and enjoyable. This is not the case anymore when we look at non-O&O students only; there, girls scored significantly higher on the perceived difficulty of doing research tasks. Furthermore, girls in this group also scored higher on Anxiety towards doing research. Differences between boys and girls in the research section are smaller within de group of O&O students, which could indicate that following the subject O&O might help girls feel more empowered to do research projects. Furthermore, it is notable that apart from differences in Self-efficacy and Context factors for doing design tasks, boys and girls within both student groups (O&O and non-O&O) did not differ on other subcategories.

This study differs from other studies in two profound ways. Firstly, we measured the attitudes of students who had followed the subject O&O weekly for 2 or 5 years. In other studies, interventions to enhance positive attitudes are often much shorter. In these studies, an increased positive attitude is often not found (Post & Walma van der Molen, 2014). Secondly, instead of looking at students' attitudes towards static concepts as 'science' or 'technology', our questionnaire focused on the performance of research and design activities. It is possible that, by using activating verbs like 'doing research at school', research and design activities are placed into a more realistic context for them, therefore possible leading to more positive attitude scores in the questionnaire.

Different types of factor analyses showed that the ADRADA questionnaire clustered according to the seven subcategories, indicating that the outcomes of the analyses are stable. Should future studies seek for improvement of this instrument, they could take into consideration the outcomes of the PCA model and group the positively formulated Anxiety items in the subcategory Enjoyment, or look carefully at the formulation of the items. The internal consistency of the Anxiety, Self-efficacy, and Context Dependency scales could also be improved by looking at the formulation of the items. On the other hand, lower internal consistency could also be inherent to the fuzzy nature of (some of) the measured concepts. For example, within the subcategory Context dependency, items on sufficient time could have been scored low, while items on available resources could have been scored high by the students.

In conclusion, this study shows that students taking the subject O&O – a context-based, student-centred subject with applied research and design tasks – had more positive attitudes towards doing research and design activities than students in regular classes. The results of this study strongly suggest that a project and context based subject like O&O could possibly enhance students' attitudes towards doing research and design activities.

The results of this study provide implications for teachers as well as teacher educators. Teachers can use the information of this study to become more aware of the existing attitudes of students, for example their preference for design projects over research projects. Teachers as well as researchers could explore how we can make doing research projects more relevant and enjoyable for students. Also, science teachers at non-O&O schools could benefit from knowing that students' anxiety appears to increase from 8th to 11th Grade, so they can take appropriate measures to enhance students' confidence and self-efficacy, for example by letting their students gain more experience in conducting authentic research and design projects.

This study provides encouraging results which are worthy to follow up on. For example, a study on the attitudes of teachers towards guiding research and design projects has been conducted by the authors to gain more insight in the existing attitudes of teachers towards this subject (Vossen, Henze, Rippe, Van Driel & De Vries, in submission). International STEM subjects could possibly also use the ADRADA questionnaire to elicit attitudes towards doing research and design activities in students who are enrolled in different STEM subjects.

Note

1. An earlier version of this paper and its corresponding research questions was presented at the 12th Conference of the European Science Education Research Association (ESERA) in Dublin, Ireland (Vossen, Henze, Rippe, Van Driel, & De Vries, 2017).

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Appendix

We used explorative principal component analyses (PCA) on both the research and design sections of the ADRADA questionnaire, that each contained 24 items that were supposed to cluster in 7 categories: Relevance, Difficulty, Enjoyment, Anxiety, Self-efficacy, Context dependency and Future. Below are the eigenvalues of the components (Table A for the research section, Table B for the design section), the correlations between the components (Table C for the research section, Table D for the design section) and the component loadings after the Varimax rotation (Table E for the research section, Table F for the design section). For tables C and D we used a Promax rotation. The pattern matrices of the Promax rotation gave the same results as the Varimax rotation, hence we chose to display the Varimax rotation in tablees E and F as it is easier to interpret. Table G represents all item numbers and their corresponding categories of the research and design components of the ADRADA questionnaire. All analyses were performed in IBM SPSS Statistics version 22.

Table A. Eigenvalues of the components in the research section of the ADRADA questionnaire.

Total Variance Explained			
		Initial Eigenvalues	
Component	Total	% of Variance	Cumulative %
1	6.149	25.623	25.623
2	2.650	11.043	36.666
3	1.742	7.257	43.923
4	1.402	5.842	49.765
5	1.320	5.499	55.264
6	1.169	4.872	60.137
7	0.963	4.013	64.149
8	0.799	3.327	67.476
9	0.735	3.062	70.539
10	0.694	2.892	73.431
11	0.653	2.722	76.152
12	0.603	2.512	78.664
13	0.598	2.492	81.156
14	0.549	2.287	83.443
15	0.534	2.225	85.668
16	0.468	1.951	87.620

(*Continued*)

Continued.

Component	Total	Initial Eigenvalues % of Variance	Cumulative %
17	0.464	1.934	89.553
18	0.431	1.797	91.351
19	0.410	1.708	93.058
20	0.393	1.636	94.694
21	0.371	1.545	96.240
22	0.330	1.376	97.616
23	0.303	1.264	98.880
24	0.269	1.120	100.000

Total Variance Explained

Extraction Method: Principal Component Analysis.

Table B. Eigenvalues of the components in the design section of the ADRADA questionnaire.

Total Variance Explained

Component	Total	Initial Eigenvalues % of Variance	Cumulative %
1	7.710	32.125	32.125
2	2.743	11.428	43.554
3	1.596	6.651	50.205
4	1.321	5.506	55.711
5	1.136	4.734	60.445
6	0.908	3.784	64.230
7	0.845	3.519	67.749
8	0.757	3.155	70.904
9	0.658	2.743	73.647
10	0.628	2.618	76.265
11	0.596	2.484	78.749
12	0.575	2.396	81.144
13	0.526	2.191	83.336
14	0.495	2.061	85.397
15	0.477	1.988	87.384
16	0.447	1.862	89.247
17	0.421	1.753	91.000
18	0.392	1.633	92.633
19	0.356	1.485	94.118
20	0.348	1.452	95.569
21	0.345	1.437	97.006
22	0.276	1.150	98.156
23	0.230	0.958	99.115
24	0.212	0.885	100.000

Extraction Method: Principal Component Analysis.

Table C. Correlations between the seven components in the research section of the ADRADA questionnaire.

Component Correlation Matrix

Component	1	2	3	4	5	6	7
1	1.000	0.506	0.402	−0.079	0.442	0.345	−0.266
2	0.506	1.000	0.371	0.040	0.319	0.156	−0.064
3	0.402	0.371	1.000	0.097	0.311	0.254	−0.124
4	−0.079	0.040	0.097	1.000	−0.128	−0.126	0.254
5	0.442	0.319	0.311	−0.128	1.000	0.382	−0.303
6	0.345	0.156	0.254	−0.126	0.382	1.000	−0.231
7	−0.266	−0.064	−0.124	0.254	−0.303	−0.231	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

Table D. Correlations between the seven components in the design section of the ADRADA questionnaire.

Component Correlation Matrix							
Component	1	2	3	4	5	6	7
1	1.000	0.591	0.476	−0.079	0.555	0.410	−0.383
2	0.591	1.000	0.434	0.062	0.341	0.197	−0.115
3	0.476	0.434	1.000	0.140	0.327	0.258	−0.108
4	−0.079	0.062	0.140	1.000	−0.067	−0.094	0.335
5	0.555	0.341	0.327	−0.067	1.000	0.423	−0.331
6	0.410	0.197	0.258	−0.094	0.423	1.000	−0.240
7	−0.383	−0.115	−0.108	0.335	−0.331	−0.240	1.000

Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization.

Table E. Component loadings after Varimax rotation in the research section of the ADRADA questionnaire.

Rotated Component Matrix[a]							
	Component						
	1	2	3	4	5	6	7
vII_1_24	0.810						
vII_1_14	0.736	0.331					
VII_1_18a	−0.719						
vII_1_9	0.667	0.418					
VII_1_6a	−0.536						0.358
vII_1_4		0.865					
vII_1_19		0.809					
vII_1_3	0.316	0.753					
vII_1_22			0.752				
vII_1_21			0.750				
vII_1_26	0.327		0.695				
vII_1_1			0.630				
vII_1_17				0.844			
vII_1_13				0.814			
vII_1_12				0.794			
vII_1_2					0.770		
vII_1_5					0.734		
vII_1_25					0.492		
vII_1_15					0.474	0.313	
vII_1_7						0.779	
vII_1_11						0.689	
vII_1_20						0.659	
vII_1_10							0.863
vII_1_23							0.853

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
[a]Rotation converged in 6 iterations.

Table F. Component loadings after Varimax rotation in the design section of the ADRADA questionnaire.

Rotated Component Matrix[a]							
	Component						
	1	2	3	4	5	6	7
vII_2_6	0.758	0.341					
vII_2_1	0.745						
vII_2_12	0.696	0.384					
VII_2_14a	−0.681						
VII_2_17a	−0.614						
vII_2_5	0.590				0.336		

(*Continued*)

Continued.

Rotated Component Matrix[a]							
	Component						
	1	2	3	4	5	6	7
vII_2_2	0.302	0.825					
vII_2_22		0.820					
vII_2_9	0.337	0.780					
vII_2_7			0.765				
vII_2_24			0.744				
vII_2_19			0.735				
vII_2_4	0.361		0.626				
vII_2_10				0.817			
vII_2_20				0.805			
vII_2_8				0.801			
vII_2_21					0.772		
vII_2_23					0.742		
vII_2_13	0.444				0.465		
vII_2_3						0.808	
vII_2_11						0.778	
vII_2_15					0.321	0.565	
vII_2_25							0.855
vII_2_16							0.833

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
[a]Rotation converged in 7 iterations.

Table G. All item numbers and their corresponding categories of the research and design components of the ADRADA questionnaire. Strike-through numbers were problematic items (which lowered the Cronbach's alpha and were not further included in the following Multilevel analyses).

Main category	Subcategory	Items in research component ADRADA (VII_1)	Items in design component ADRADA (VII_2)
Cognition	Relevance	21, 22, 26	4, 7, 19, 24
	Difficulty	12, 13, 17	8, 10, 20
Affec	Enjoyment	9, 14, 24	1, 6, 12
	Anxiety	6a, 10, 18a, 23	14a, 16, 17a, 25
Control	Self-efficacy	2, 5, 15, 25	5, 13, 21, 23
	Context	7, 11, 20	3, 11, 15
Behaviour	Future	3, 4, 19	2, 9, 22