

Self-efficacy of undergraduate dental students in Endodontics within Aarhus and Amsterdam

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Abstract

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Aim To understand whether the self-efficacy of undergraduates is associated with the extent of the endodontic education they received.

Methodology Data were obtained from three undergraduate endodontic programmes in two universities: Aarhus University (AU), Denmark and the Academic Centre for Dentistry Amsterdam (ACTA), the Netherlands. Just before their graduations in 2016 or 2017, students completed a questionnaire that contained the Endodontic General Self-Efficacy Scale and questions on how they valued the education they received in Endodontics. The information on the number and type of root canal treatments participants had performed on patients was collected from dental clinic management systems. Data were analysed using non-parametric tests and multiple regression analyses.

Results The median number of treated root canals on patients per student was 5 in the standard programme at ACTA, 10 in AU, and 14.5 in the extended programme at ACTA. Students' self-efficacy increased with the number of treated root canals; however, retreatments and root canal treatments in molars were negatively associated with self-efficacy. All students wanted more experience in performing root canal treatment on patients.

Conclusions The endodontic self-efficacy of students from the standard programmes of the two participating universities was comparable. Students' self-efficacy was influenced mostly by their clinical experience when performing root canal treatment. It seems that the more root canal treatments students perform on patients, the greater their self-efficacy is at graduation. However, treating difficult cases (molars and retreatments) might reduce their self-efficacy.

Keywords: education, endodontics, root canal treatment, self-efficacy, undergraduate.

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Introduction

Root canal treatments are considered challenging and stressful by general dental practitioners (Dahlström *et al.* 2017). For the technical procedure of root canal treatments, quality guidelines are available (European Society of Endodontology 2006), and the skills to perform uncomplicated root canal treatments ought to be acquired during undergraduate dental training (Cowpe *et al.* 2010, European Society of Endodontology 2013). Although most general dental practitioners acknowledged the importance of quality treatment

and perceive they are competent to conduct root canal treatments (Bjørndal *et al.* 2007), they tend to perform root canal treatment with inadequate adherence to quality guidelines and below the standard of care (Peciuliene *et al.* 2009, Peters *et al.* 2011, Kirkevang *et al.* 2014, Neukermans *et al.* 2015, Dahlström *et al.* 2018, Kirkevang 2018). It has been documented that challenging cases are being referred to endodontic specialists with increasing frequency (Neukermans *et al.* 2015).

Self-efficacy refers to feelings of competence and confidence defined as self-assurance that you will be able to perform specific tasks successfully. Being competent is a prerequisite for self-efficacy (Bandura 1977). Self-efficacy has a direct positive effect on performance (Pajares & Miller 1994) and is positively associated with making use of academic competencies (Zimmerman 2000). Challenging tasks are more readily undertaken by those individuals with higher self-efficacy (Zimmerman 2000). Furthermore, individuals with high self-efficacy exhibit greater perseverance and perform under stressful situations better than individuals with low self-efficacy (Bandura 1977, 2006). The performance of general dental practitioners when performing root canal treatment has been hypothesized to be influenced by their self-efficacy (Baaij & Özok 2018a). In summary, increasing practitioners' self-efficacy is expected to increase the quality of care.

Research is lacking on the self-efficacy of general dental practitioners in relation to Endodontics. Furthermore, not much is known about the self-efficacy of undergraduate dental students. Undergraduate dental curricula are based on a list of competences that the student has to achieve to be able to work independently in a dental practice following graduation (Cowpe *et al.* 2010, European Society of Endodontology 2013). However, not all students feel confident after graduation (Murray & Chandler 2014, Davey *et al.* 2015).

The aim of the present study was to understand whether the self-efficacy of undergraduates is associated with the extent of the endodontic education they received. Data from two universities (Aarhus University, AU, Denmark and the Academic Centre for Dentistry Amsterdam, ACTA, the Netherlands) were obtained and compared.

Materials and methods

The research protocol of this study was independently reviewed and approved by the ethics committee of ACTA under the reference number 2017014.

Education in Endodontics at both AU and ACTA adhere to the undergraduate curriculum guidelines of the European Society of Endodontology (2013) and the profile and competences for the European dentist of the Association for Dental Education in Europe (ADEE guidelines; Cowpe *et al.* 2010).

In Denmark, dentistry is 5 years of study. At AU, the education in Endodontics is given in the third year, where the students have 30 h of lectures, 30 h of preclinical exercises at a simulation clinic set-up, and eight clinical seminars. At graduation all students are expected to have performed root canal treatment of at least eight root canals in patients. The simulation exercises include root canal treatment of extracted human teeth: one anterior tooth, one premolar and one molar, all mounted in artificial jaws on manikin heads. Furthermore, they prepare and cement a post, and perform surgical endodontic retreatment on one tooth mounted in an artificial jaw. Before engaging in treatment of patients, the clinical instructor must approve the completion of the preclinical course work, and the students must pass a formal test in Endodontics. At the student clinic, the students work in pairs. The supervising instructor gives formal feedback including on self-evaluation and feedback after each session. Finished and approved treatments are registered in the dental clinic management system KLIPS. At the end of the fifth year of the study, the students have a final examination. Here, the student must make a comprehensive treatment plan based on anamnestic, clinical and radiographic information. The treatment plan covers all aspects of the necessary dental treatment including endodontics. The student is given 15 min to present the plan and is afterwards examined for 45 min.

In the Netherlands, dentistry is 6 years of study. The education in Endodontics at ACTA starts in the second year with 13 h of lectures, 2 h of tutorials, 32 h of preclinical training and an optional blended and problem-based learning course, that almost all students attend. In the fourth year, the students follow a 4-week course that consists of 5 h of lectures and 7 h of tutorials on dental pain and traumatology. In the same year, the students follow a 10-week course which consists of 6 h of tutorials where discussions on scientific literature and clinical cases take place. In addition to the tutorials, the students follow 25 h of simulated clinical training during which they perform root canal treatment in a maxillary incisor, a maxillary molar and a mandibular molar, that are mounted in artificial jaws in manikin heads that are

fixed to the dental chairs in the clinic. The students are supervised by endodontists and conclude this course with a summative assessment. Here, the student receives an endodontic case including patient anamneses, clinical findings and a periapical radiograph. The student then makes a diagnosis and a treatment plan based on this diagnosis and performs this treatment on an extracted human molar that is mounted in an artificial jaw in a manikin head that is fixed to a dental chair in the clinic. Consequently, students reflect on the treatment and their performance, which is evaluated by endodontists. Only passing students are allowed to perform root canal treatments on their patients in the clinic and only under supervision. A requirement to proceed to the final year is that the student has performed root canal treatment of at least three root canals in patients. Throughout their study, students are expected to apply their endodontic knowledge into their treatment planning, and this is tested on several occasions. At the final year of the undergraduate curriculum, an additional elective course in Endodontics is available, and approximately 17% of the students choose this course. The additional elective course consists of 21 h of tutorials to discuss endodontic literature and 128 h in the clinic to perform more complicated root canal treatments, on patients and on extracted human teeth, under supervision of endodontists. This course is open to all final year students.

For the present study, all undergraduate dental students from AU and ACTA who were in their final year in 2016 or 2017 were invited to participate

close to their graduations. The students were informed that the data would be processed anonymously. Participating students gave informed consent. Participation included completing a paper questionnaire that contained the Endodontic General Self-Efficacy Scale (Table 1) (Baaij & Özok 2018a) and questions on the appreciation of the amount of education the students received in endodontics (Table 2). The questionnaires were in their national languages and also provided space for the students to give supplementary comments.

In 2016, 50 students graduated from AU and 62 from ACTA, and in 2017, the figures were 45 and 109, respectively. The participation rates from AU were 94% in 2016 and 78% in 2017 and from ACTA 77% and 62%, respectively. The students from ACTA were divided into two groups, based on their participation in the additional elective course in the final year. Students who had taken the additional elective course in Endodontics were categorized as 'ACTA extended'; the remaining students from ACTA were categorized as 'ACTA standard'. Four participants who graduated in 2017 from ACTA could not be categorized since it was not clear whether they had taken the additional elective course in Endodontics or not. Table 3 shows the sample. Information on the participants' clinical experience in performing root canal treatments on patients was retrieved from the dental clinic management systems of the institutions (Table 4). However, 12 participants (including the abovementioned four students who could not be categorized) did not provide the information necessary to

Table 1 The Endodontic General Self-Efficacy Scale

The Endodontic General Self-Efficacy Scale	Not at all true	Hardly true	Moderately true	Exactly true
1 I can always manage to solve difficult endodontic problems if I try hard enough	1	2	3	4
2 If a patient opposes me, I can find the means and ways to get what I want	1	2	3	4
3 It is easy for me to stick to my endodontic aims and accomplish my goals	1	2	3	4
4 During an endodontic treatment, I am confident that I could deal efficiently with unexpected events	1	2	3	4
5 Thanks to my resourcefulness, I know how to handle unforeseen endodontic situations	1	2	3	4
6 I can solve most endodontic problems if I invest the necessary effort	1	2	3	4
7 I can remain calm when facing difficulties concerning an endodontic case because I can rely on my coping abilities	1	2	3	4
8 When I am confronted with an endodontic problem, I can usually find several solutions	1	2	3	4
9 If I am in trouble during an endodontic treatment, I can usually think of a solution	1	2	3	4
10 I can usually handle whatever comes my way during endodontic treatment	1	2	3	4

Table 2 Questions used to measure students satisfaction with content and extent of education

I would have had more	
Literature	Yes/no
Lectures	Yes/no
Clinical seminars/Tutorials	Yes/no
Preclinical/Simulated clinical training	Yes/no
Root canal treatments on patients	Yes/no
Difficult cases of root canal treatments on patients	Yes/no
Feedback on my performance from my supervisor	Yes/no
Feedback on my performance from my peer	Yes/no
I would have had less	
Literature	Yes/no
Lectures	Yes/no
Clinical seminars/Tutorials	Yes/no
Preclinical/Simulated clinical training	Yes/no
Root canal treatments on patients	Yes/no
Difficult cases of root canal treatments on patients	Yes/no
Feedback on my performance from my supervisor	Yes/no
Feedback on my performance from my peer	Yes/no

retrieve data on their experience and were omitted from the analyses.

Data treatment and statistical analyses

For each of the three programmes, the number of teeth treated by the students was tabulated according to tooth type and calendar year. Non-parametric tests were used for comparisons. Questionnaire data were tabulated according to programme and year. The total self-efficacy score, computed as the sum of the scores from the 10 questions of the Endodontic General Self-Efficacy Scale, was studied by multiple regression analyses. Three regression models were considered: Model 1 included programme and calendar year as independent variables. In Model 2, the number of treated canals was included as an additional independent variable, and in Model 3, the number of retreatment and the number of treated molars were further included. Stata Release 15 (Stata

Table 3 Number of undergraduate dental students in the study sample from ACTA and AU in 2016 and 2017

Year	ACTA		AU
	Standard	Extended ^a	
2016	38	10	47
2017	46	18	35
Total	84	28	82

^aStudents who had Endodontics as an elective course during their final year of dental education, in addition to the standard education all students at ACTA receive in Endodontics

Corp. 2017; College Station, TX, USA) was used for all statistical analyses.

Results

For both universities, the overall number of root canal treatments was lower in 2017 compared to 2016 ($P = 0.01$), but this did not influence the self-efficacy score, and information from the 2 years was therefore combined in tables and figures. The number and types of root canal treatments performed by the students are described in Table 4.

All participants completed the Endodontic General Self-Efficacy Scale. For each of the three programmes, the distribution of the students' responses to the ten questions of the Endodontic General Self-Efficacy Scale (Table 1) is shown in Fig. 1. In all programmes, the students' self-efficacy increased with the number of treated root canals (Fig. 2). The students at AU and the students attending the standard programme at ACTA had similar self-efficacy profiles, whereas the students attending the extended programme at ACTA had in general higher self-efficacy scores. The results of three multiple regression analyses with total self-efficacy score as the dependent variable are shown in Table 5. Model 1 revealed that the self-efficacy was significantly higher for students in the extended programme at ACTA than for students in the standard programme at ACTA. The self-efficacy of students from AU did not differ significantly from that of students in the standard programme at ACTA. However, when the number of treated root canals was included in the analysis (Model 2), it was revealed that the students at AU had significantly lower self-efficacy than those of the standard programme at ACTA, and the difference between the standard and the extended programmes at ACTA was no longer significant. When also the number of retreatments and the number of treated molars were included in the analysis (Model 3), there were no longer significant differences between the programmes. The regression coefficient for the number of treated root canals was positive. However, for retreatments and the treatment of molars, the regression coefficients were negative.

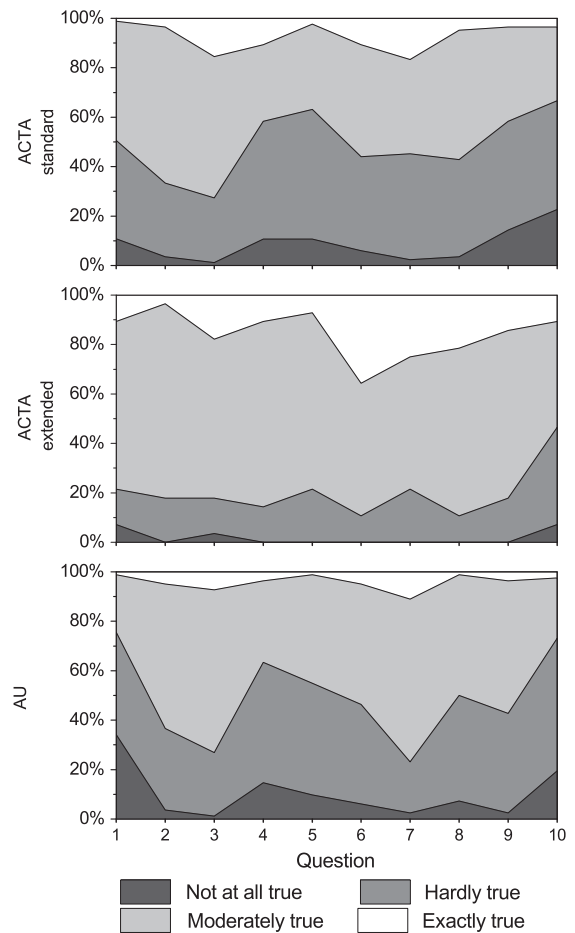
Two participants did not complete one or more of the 'I would have had more' questions, and six participants did not complete some or all of the 'I would have had less' questions. Figure 3 shows of which components students would have had more during their undergraduate education. Components of which students would have had less were identified by very

Table 4 Clinical experience of students in performing root canal treatments during their undergraduate dental training

No of teeth	ACTA		AU
	Standard	Extended	
Anterior			
0	39	6	17
1	30	7	31
2	6	8	24
3	5	2	4
4		2	2
5			2
8		1	
Total ≥ 1	41 (51%)	20 (77%)	63 (79%)
Premolar			
0	22	3	16
1	33	7	26
2	13	8	24
3	11	2	10
4	1	5	4
5		1	
Total ≥ 1	58 (73%)	23 (88%)	64 (80%)
Molar			
0	24		
1	42	3	17
2	11	3	40
3	3	8	16
4		11	7
5		1	
Total ≥ 1	56 (70%)	26 (100%)	80 (100%)
Retreatment			
0	74	6	24
1	5	8	32
2		7	17
3		5	3
4			3
5			1
Total ≥ 1	5 (6%)	20 (77%)	56 (70%)
Teeth			
Median no.	3	6	5
Canal			
Median no.	5	14.5	10

For different types of root canal treatments, the number of students who performed the specified numbers of treatments on patients is presented on tooth level. This is complemented with the total number of students who gained experience in this type of treatment on patients (i.e. the sum of students who performed one or more root canal treatments of this type on patients) and its percentage in regard to all the students within the corresponding programme. Finally, for every programme, the median number of total root canal treatments on patients is given, both on tooth level and on root canal level.

few students of AU. Students from the extended programme at ACTA requested less lectures (21%), less simulation clinics (18%) and less feedback from other students (14%). A similar tendency, but less pronounced, was seen among the students from the standard programme at ACTA.

**Figure 1** Distribution of the students' responses to the 10 questions of the Endodontic General Self-Efficacy Scale.

Discussion

For this study, all students of two successive years of graduation from two universities in two European countries with, in total, three endodontic programmes were invited. The participation rates were satisfactory (Draugalis *et al.* 2008); and the internal consistency of both the Danish and the Dutch versions of the Endodontic General Self-Efficacy Scale appeared to be good in this study (Cronbach's alpha = 0.878 and 0.872 respectively), and similar to what has previously been reported (Baaij & Özok 2018a). The diverse sample provided data that seemed generalizable.

The participants' comments indicated that they appreciated the endodontic education they received. Most of the students were satisfied with the amount of lectures, literature and simulated clinical training.

Nearly half of the students wanted more tutorials to discuss literature and/or clinical cases, and more feedback from their teachers, but this may probably reflect the considerable variability in students' learning preferences (Divaris *et al.* 2008). Students appreciated the supervision by endodontists (ACTA) or teachers with special interest and knowledge in Endodontics (AU), as became clear from their comments. Supervision by teachers with advanced knowledge and skills in Endodontics is advised by the ESE guidelines (European Society of Endodontology 2013), and increasing numbers of treatments under their supervision increases self-efficacy (Baaij & Özok 2018a). Almost all students in this study would like to have had performed more root canal treatments on patients during their undergraduate dental training.

The ADEE and ESE guidelines state that students should be competent to perform root canal treatment on uncomplicated anterior and posterior teeth (Cowpe *et al.* 2010, European Society of Endodontology 2013); and according to the ESE guidelines, students should gain adequate clinical experience in the treatment of anterior, premolar and molar teeth (European Society of Endodontology 2013). The precise meaning of the phrase 'adequate clinical experience in the treatment of anterior, premolar and molar teeth' used in the ESE guidelines may be elusive, but it might be concluded that many students in the present study sample did not achieve that (Table 4). For students, opportunities to gain clinical experience depend on

the available patients and the types of treatments they need. Clinical experience and requirements of a mandatory number of procedures vary widely between undergraduate programmes globally, and there are even programmes that have no such requirements at all (Gatley *et al.* 2009, Seijo *et al.* 2013, Tanalp *et al.* 2013, Murray & Chandler 2014, Alrahabi 2017). The arguments for quantitative requirements 'to ensure clinical competence' are a traditional mystery (Chambers 2012). Currently, a competency based approach is recommended (Cowpe *et al.* 2010) and requirements for graduation are given in a list of competencies instead of fixed numbers of treatments; no recommendations are made on the appropriate number of root canal treatments (European Society of Endodontology 2013). For ethical reasons and patient safety, the students must already be competent when they start performing root canal treatment on patients. At this point, the students are supposed to have reached a maintenance stage of learning, and the number of additional root canal treatments to be performed on patients in order to further improve performance is not achievable during undergraduate education (Chambers 2012). The value of performing root canal treatments on patients during undergraduate education might actually be to transition from competent to self-efficacious, rather than increasing the level of competence.

Self-efficacy increases due to positive experiences, but it decreases due to negative ones, particularly if

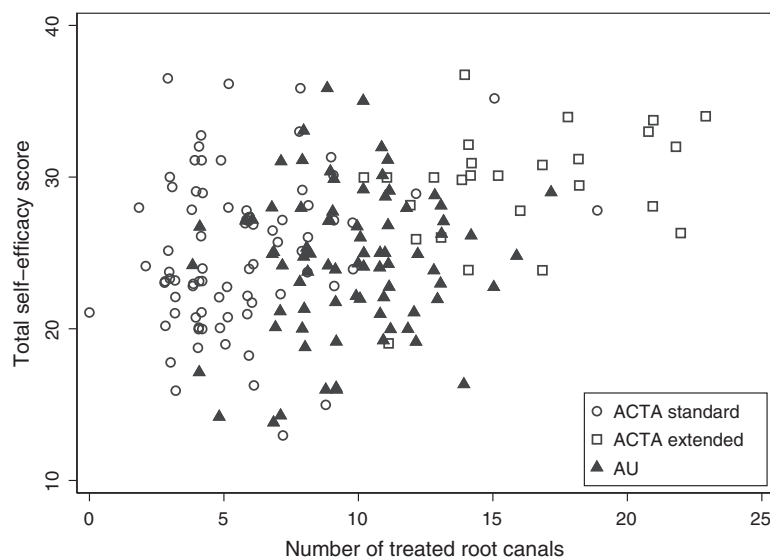


Figure 2 Students' self-efficacy (total self-efficacy score) plotted against number of treated root canals on patients.

Table 5 Results of three multiple regression analyses with students' self-efficacy (i.e. total self-efficacy score) as the dependent variable

Variable	Model 1			Model 2			Model 3		
	Coeff.	SE	P-value	Coeff.	SE	P-value	Coeff.	SE	P-value
Programme									
ACTA standard	Reference			Reference			Reference		
ACTA extended	4.47	1.02	<0.001	0.72	1.67	0.67	1.49	1.70	0.38
AU	-0.56	0.73	0.45	-2.08	0.88	0.02	-1.18	0.98	0.23
Year									
2016	Reference			Reference			Reference		
2017	-0.36	0.68	0.60	0.44	0.72	0.55	0.26	0.73	0.72
No of treated root canals				0.36	0.12	0.004	0.52	0.16	0.002
No of retreatments							-0.73	0.43	0.09
No of molars							-0.66	0.53	0.22
Constant	25.17	0.63		22.82	1.03		22.66	1.04	

Model 1 includes programme and year as independent variables; Model 2 includes programme, year and number of treated root canals on patients as independent variables; and Model 3 includes the independent variables included in Model 2 supplemented with both the number of retreatments and the number of molar treatments that the students performed on patients.

they occur early in the course of events when no or only little positive experience has gained (Bandura 1977). Both retreatments and root canal treatments in molars were negatively associated with self-efficacy. Such treatments can be regarded as 'difficult' (Tanalp *et al.* 2013, Murray & Chandler 2014, Davey *et al.*

2015) and may evoke a negative experience to the student (Tanalp *et al.* 2013). It is debatable whether undergraduate students should be introduced to difficult cases at all (Tanalp *et al.* 2013). One might conclude that, to increase self-efficacy, students should perform as many root canal treatments as possible,

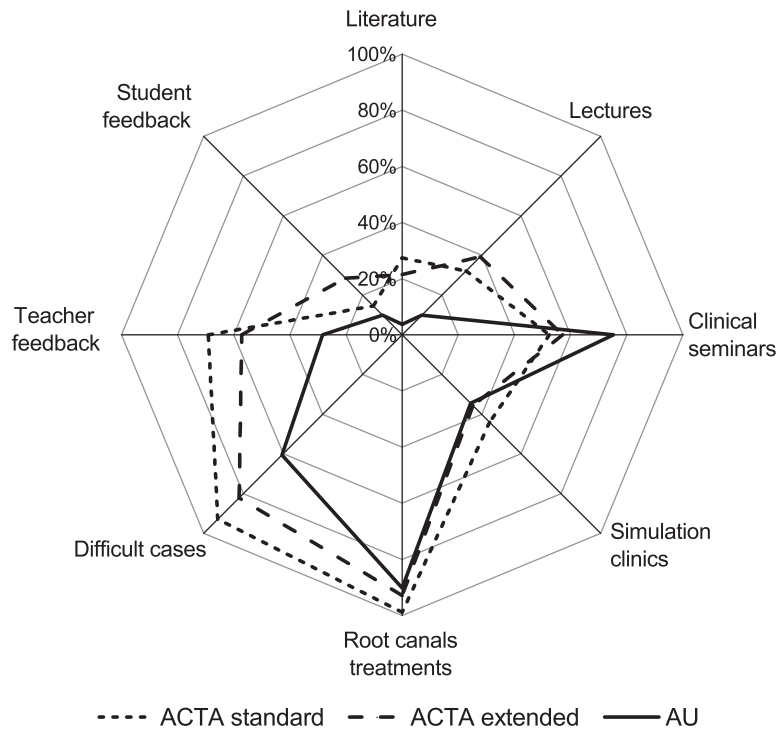


Figure 3 Students' satisfaction with the extent of education. For each component, the radar plot shows the proportion of students wanting more of this particular component.

but not too difficult ones. Interestingly, most participants of the present study did request more difficult root canal treatments on patients. It is important for students to be aware of the boundaries of their capabilities (Cowpe *et al.* 2010, European Society of Endodontology 2013) and having experience with more difficult cases might make them more aware of the reality of handling such cases (Murray & Chandler 2014). Although students might want to push those boundaries to acquire advanced competences in Endodontics (Tanalp *et al.* 2013, Murray & Chandler 2014, Baaij & Özok 2018a), patient safety should always be the prime concern. One of the participants of the standard programme at ACTA commented: 'I learned a lot from the supervising endodontist in the emergency clinic. If I cannot handle a case myself, I will refer the patient to an endodontist'. The Dutch Endodontic Treatment Index and Endodontic Treatment Classification are used by students and general practitioners in the Netherlands to assess difficulty; cases that are regarded too difficult are referred to an endodontist (Ree *et al.* 2003). In the Netherlands, a 3-year full-time postgraduate programme in Endodontics, recognized by the Netherlands Society for Endodontology (NVvE), is available. In Denmark, possibilities to refer are more restricted since there no such programme is available. The present investigation further raises the question of the need for a formalized postgraduate programme in Endodontics in Denmark.

The undergraduate clinical training should reflect the types of treatments that the students are expected to perform when they enter clinical practice after graduation (Divaris *et al.* 2008). Not only a certain level of competency should be acquired, preferably in simulation (Baaij & Özok 2018b), this acquired level of competency should be retained, and self-efficacy should then be built further. To raise self-efficacy, root canal treatments of lower difficulty levels on patients are preferred to start with. The number of available patients who need root canal treatment of a suitable difficulty level for the undergraduate students is limited, not only at AU and ACTA, but in many dental schools (Divaris *et al.* 2008). In an attempt to compensate for limited time and suitable cases, students at AU perform treatments in pairs. If peer students train in pairs, they reach similar level of competence as students who train alone and perform double the amount of treatments (Bjerrum *et al.* 2014). A similar effect of training in pairs could not be observed on students' self-efficacy in the present study; the study

was not designed with particular focus on assessing this effect. Although students at ACTA are not trained to work in pairs, they usually work with a peer while performing root canal treatment on patients. Future research should investigate the influence of training in pairs on students' self-efficacy in Endodontics.

The findings of the present investigation could be useful in improving undergraduate programmes to increase students' self-efficacy in Endodontics. To further understand self-efficacy and how it is related to undergraduate education, it would be interesting to study the self-efficacy of students in other endodontic programmes as well. Further research should not only focus on comparisons of the self-efficacy of students between other universities in other countries, but also on other factors that might influence the self-efficacy in Endodontics, such as the possible effect of graduation and clinical experience outside the dental institution. Another interesting direction in this line of research is investigating the expected relation between the self-efficacy of both students and general dental practitioners and their performances in the clinic.

Conclusion

The self-efficacy regarding Endodontics of undergraduate students from the standard programmes of the two participating universities is comparable. Students' self-efficacy appeared mostly influenced by their clinical experience when performing root canal treatment. The more root canal treatments students perform on patients, the greater their self-efficacy is at graduation. However, treating difficult cases (molars and retreatments) might reduce their self-efficacy.

Students of both universities seem mainly satisfied with the amount of education they receive. They request, though, more experience in performing root canal treatments.

Conflict of interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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