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ORIGINAL ARTICLE

Influence of Method of Teaching Endodontics on the Self-Efficacy and Self-Perceived Competence of Undergraduate Dental Students

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ABSTRACT

Objective: This study assessed whether self-efficacy and the self-perceived competence of undergraduate dental students had been influenced by the method of teaching endodontics.

Methods: Certain modules of the undergraduate endodontic programme at the Academic Centre for Dentistry Amsterdam (ACTA) including the tutorials, the clinical training and the assessment were revised. The self-efficacy and self-perceived competence close to graduation of an intermediate cohort of 24 students who attended all or some of the former modules or the revised modules were assessed. Additionally, the performance of students in performing root canal treatments was assessed according to predetermined criteria. Data were analysed using Cohen's Kappa, Cronbach's Alpha, Mann-Whitney and T-tests.

Results: Self-efficacy and the self-perceived competence of students who followed the former modules of clinical training and assessment were similar to those of students who followed the revised modules. The revised module with higher number of tutorials increased students' self-perceived competence, but did not influence their self-efficacy statistically significantly. Not the entire number, but the number of root canal treatments performed under supervision of endodontists was related with an increase in students' self-efficacy and self-perceived competence. The performance of students in performing root canal tretaments was not statistically significantly related to their self-efficacy and self-perceived competence.

Conclusion: Among the modules and their components assessed in the present study, only the number of tutorials and the number of root canal treatments performed under supervision of endodontists influenced the self-efficacy and the self-perceived competence of students.

Keywords: Educational measurement, endodontics, self concept, self efficacy, self-perceived competence, teaching

HIGHLIGHTS

- The method of teaching endodontics can influence the self-efficacy and self-perceived competence of undergraduate dental students.
- This work implies that not only skills are important, but also self-efficacy. Self-efficacy is expected to influence how an undergraduate dental student, and following graduation, a general dental practitioner, will handle endodontic cases and how successful they will be.
- The Endodontic General Self-Efficacy Scale may be used to assess the self-efficacy since it seems to be a reliable test.

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INTRODUCTION

For a general dental practitioner, having to perform a root canal treatment can be stressful (1). To a great extent, a person's action and the amount of effort they will exert while dealing with stressful situations is determined by their self-efficacy (2). Being appropriately skilled is a prerequisite (2).

The majority of root canal treatments are performed by general dental practitioners. There are conflicting reports about how well, in their own perception, dental graduates or students who are about to graduate had been prepared for their work as general dental practitioner by their undergraduate endodontic education (3, 4). Many of them felt unprepared and not very confident (5-7) about performing complex endodontic treatments. They felt incompetent performing uncomplicated root canal treatments as well (8).

Studies assessing the effect of different methods of teaching endodontics on the confidence, the feelings of preparedness and the competence of students are scarce. One of the few available studies provided evidence for the value of a teaching method, which was new at that time and based upon independent learning, structured reflection and self-assessment. This method of teaching increased the feelings of preparedness of the students and their confidence in their practical skills. It also encouraged students to pursue understanding (9).

So far, no research assessing the effect of methods of teaching endodontics has measured students' self-efficacy. Self-efficacy embraces more than confidence and feelings of preparedness and competence. It is situation-specific self-confidence; the conviction that one can successfully execute the behaviour required to produce an intended outcome (2). Students' self-efficacy is responsive to changes in teaching methods and plays a causal role in their development and use of academic competencies (10). Students with high self-efficacy undertake difficult and challenging tasks more readily than students with low self-efficacy do (10). Moreover, the higher the self-efficacy, the greater the perseverance and the higher the likelihood that the task will be performed successfully (11). Therefore, students' self-efficacy is expected to determine how much effort dental graduates will exert into performing endodontic treatments.

In 2010, the undergraduate dental curriculum at our institution was extended, and the endodontic programme was revised. The main changes concerned the increased number of tutorials, the method of clinical training, the method of summative assessment, the number of root canal treatments required and the supervision while performing endodontic treatment on patients. Students who attended the revised modules and components became at least as skilled in performing root canal treatment as the students who attended the former ones (12). In the present study, it was assessed on module and component level whether self-efficacy and the self-perceived competence of students who were about to graduate had been influenced by the method of teaching endodontics.

METHODS

The institutional research board of the Academic Centre for Dentistry Amsterdam approved the research protocol on 16 November 2012.

Former module of clinical training started with a preclinical training where students performed root canal treatments in extracted teeth. This training was basically on a tooth level, and the actual situation with a patient was not well simulated. This module proceeded with students performing root canal treatments on patients under supervision of the general dental practitioners. As a requirement for graduation, students had to perform several root canal treatments, including at least one in a molar, and had to pass a summative assessment. This former module of assessment comprised performing a root canal treatment in a premolar or a molar on a patient. During this summative assessment, students needed to demonstrate that they were able to perform root canal treatment of good quality without assistance of a supervisor.

Currently, in the revised clinical training module following the preclinical training, students proceed with a better simulated clinical training. This training comprises performing root canal treatments on extracted human teeth under conditions that closely mimic the actual situation with a patient: the teeth are mounted on an artificial jaw in a manikin head fixed to a dental chair in the clinic, and students have to act, and perform the treatment, as if it is a real patient. During this simulated component of the module, the students are supervised by endodontists. The revised module of assessment comprises a root canal treatment in a molar under the same strictly simulated conditions where the students demonstrate that they are able to perform root canal treatment of good quality without assistance of a supervisor. Passing this summative assessment is a requirement for students to be allowed to proceed to the last component of the revised clinical training module. In this component, unlike the former clinical training module, there are no minimum requirements regarding the number of root canal treatments performed on a patient before graduation. The students may graduate when they are considered well prepared for the task of a general dental practitioner. The preparedness for this task is assessed with the use of a formative assessment. The supervision component of the clinical training module has been revised as well. Currently, the students are supervised by general dental practitioners or by endodontists.

The number of tutorials in the revised theoretical training module has been increased. One extensive tutorial in the former module is replaced with trimester-long weekly tutorials guided by an endodontist. During those tutorials, various clinical cases, including the diagnoses, aetiology, prognoses, treatments and on-topic current endodontic literature, are discussed.

As a result of the implementation of the curricular changes, an intermediate cohort comprising students following the whole or a part of the former undergraduate endodontic programme and students following the whole or a part of the revised undergraduate endodontic programme had been formed. The students of this intermediate cohort, who differed in the combinations of modules and components they attended, were asked to volunteer in the present study in their final months prior to graduation. They were informed that the purpose of the present study was to evaluate the influence of teaching methods on their experience in endodontics, and that since their answers would be completely blinded, the researchers would be unable to link the data obtained to a specific student. Only after giving permission to use their data were students able to participate. Participation comprised filling out an online questionnaire that was composed for the present study.

Self-efficacy was assessed using the Dutch Adaptation of the General Self-Efficacy Scale (Bart Teeuw, Ralf Schwarzer & Matthias Jerusalem, Berlin, Germany, 1994), whose questions were

adapted to endodontics. This adapted scale was named the 'Endodontic General Self-Efficacy Scale'.

Self-perceived competence was assessed using a self-composed questionnaire, the English translation of which is shown in Table 1. To be consistent, for this 'Endodontic Self-Perceived Competence Scale', like the Endodontic General Self-Efficacy Scale, a four-point Likert-type format was used. Self-perceived competence was defined as the sum of the answers to questions 1 to 10.

Questionnaires are most effective if the separate questions of different questionnaires are mixed to form one combined questionnaire. The two questionnaires (i.e. the Endodontic General Self-Efficacy Scale and the Endodontic Self-Perceived Competence Scale) were, therefore, merged, and the separate questions of the scales randomly mixed to form one combined questionnaire. The online questionnaire contained this combined questionnaire and additional questions about the type of undergraduate endodontic programme the students followed. These questions concerned whether they attended the revised or former theoretical training modules, modules of assessment and clinical training modules as well as how many root canal treatments they performed on patients under supervision of the general dental practitioners and how many under supervision of the endodontists. It was assumed that the students answered the questions honestly.

All participants can be considered appropriately skilled in performing root canal treatment since they all succeeded in the summative assessment. Still, there might be differences in their performance. Therefore, two observers assessed the quality of the first root canal treatment the students performed on a patient, following succeeding in the summative assessment. This assessment was performed on a radiograph with the use of predetermined criteria. The quality of the treatment was evaluated per root canal, and it was scored as 'good' when it met the following criteria: root filling follows the natural root canal and is completely within the confines of the root (no extrusion); root filling ending not shorter than 0-2 mm from the apex; root filling appears well condensed on the periapical radiograph and no ledges, perforations, transportations or separated instruments are detectable on the periapical radiograph or reported in the chart. The quality of the root canal treatment under investigation was scored as 'good' when all the root canals of the corresponding tooth were scored as 'good'. In case of disagreement between the observers, a discussion took place until a consensus was reached. To determine the intra-observer reliability, the assessment was repeated on one-fourth of the sample a few months after the initial evaluation.

Statistical analysis

Data were analysed using IBM SPSS Statistics version 21.0 software (IBM Corp.; Armonk, NY, USA). The separate questions were ordinal data and therefore analysed using Mann-Whitney U tests. Self-efficacy and self-perceived competence were considered numerical data and therefore analysed using Independent Samples T-tests. Furthermore, Cronbach's alpha and Cohen's kappa tests were used to analyse the reliability of the questionnaires and the observers, respectively.

RESULTS

Twenty-four students participated in the present study. Data are presented in Table 1. Self-efficacy and the self-perceived competence of students who followed the former modules of clinical training and assessment were similar to those of students who followed the revised modules. However, students who attended the revised clinical training module reported a lower need for extra education in endodontics to maintain their competence than students who attended the former clinical training module. Not the entire number of root canal treatments on patients, but the number of treatments performed under supervision of the endodontists was related with an increase in students' self-efficacy and self-perceived competence. The students' self-efficacy was higher when they performed more than two root canal treatments under supervision of the endodontists (P=0.034). Their self-perceived competence was higher when they performed more than three (P=0.022) or more than four (P=0.049) root canal treatments under supervision of the endodontists. The revised theoretical training module with higher number of tutorials increased students' self-perceived competence, but did not statistically significantly influence their self-efficacy.

Since two of the participants did not perform a root canal treatment on a patient between the summative assessment and the time of the evaluation, the quality of the root canal treatment was determined for 22 participants. Sixty-eight percent of the evaluated root canal treatments were of good quality. Students who performed root canal treatment of good quality answered the question 'I know how to manage complications that may occur while performing endodontic treatment' more positively than those who performed root canal treatment of poor quality. The performance of students in performing root canal treatments was not statistically significantly related to their self-efficacy and self-perceived competence.

DISCUSSION

Self-efficacy is different from self-concept, perceived control and outcome expectancies (Figure 1) and has discriminant validity in predicting a variety of academic outcomes (10). Both within and outside the medical field, self-efficacy is used in various educational studies and seems a valid outcome measure for testing teaching methods in endodontics as well. To use self-efficacy as an outcome measure, the questionnaire has to be adapted to the specific tasks (10). A Cronbach's alpha value of 0.874 for the Endodontic General Self-Efficacy Scale suggests that the internal consistency of this scale is good. It can, therefore, be considered as a reliable method to test the self-efficacy of the undergraduate dental student.

Being appropriately skilled is a prerequisite for self-efficacy (2). All participants in the present study can be considered appropriately skilled in performing root canal treatment since they

TABLE 1. The separate questions of the Endodontic Self-Perceived Competence Scale together with the four-point Likert-type scale, supplemented by self-perceived competence and self-efficacy determined with the Endodontic General Self-Efficacy Scale

	Separate questions of the Endodontic Self-Perceived Competence Scale	Not at all true	Hardly true	Moderately true	Exactly true	Mean±SD	Range	Clinical training module P	Module of assessment P	Theoretical training module P	Performance in performing root canal treatment P
1	I feel competent to diagnose independently.	1	2	3	4	3.3±0.5	2-4	0.963	0.490	0.301	0.802
2	I feel competent to determine independently the difficulty level of an endodontic treatment.	1	2	3	4	3.2±0.8	1-4	0.966	0.874	0.452	0.526
3	I feel competent to perform independently endodontic treatments on patients.	1	2	3	4	2.9±0.7	1-4	0.727	0.689	0.263	0.339
4	I feel competent to reflect independently on the procedure and to determine the prognosis of the tooth after finishing endodontic treatment on a patient.	1	2	3	4	3.0±0.7	2-4	0.493	0.556	0.582	0.818
5	I estimate my endodontic skills equal to those expected of a general dental practitioner.	1	2	3	4	2.3±0.7	1-3	0.640	0.370	0.938	0.906
6	I worry about encountering complications while performing endodontic treatment.	4	3	2	1	2.6±0.9	1-4	0.616	0.490	1.000	0.642
7	While performing endodontic treatment, I know how to minimise risks of iatrogenic damage.	1	2	3	4	3.4±0.5	3-4	0.468	0.934	0.280	0.673
8	I know how to manage complications that may occur while performing endodontic treatment.	1	2	3	4	2.7±0.6	2-4	0.687	0.485	0.806	0.022*
9	In root canal treatments difficulty levels DETI A and DETI B class I, everything is clear to me: I know and understand everything, and I can substantiate and explain it all.	1	2	3	4	3.0±0.8	1-4	0.305	0.531	0.327	0.119
10	I have a need for extra education in endodontics because I lack skills and knowledge in endodontics.	4	3	2	1	2.0±0.8	1-3	0.435	0.910	0.163	0.330
11	I have a need for extra education in endodontics because I have a special interest in endodontics.	1	2	3	4	3.0±0.6	2-4	0.106	0.902	0.510	0.101
12	I have a need for extra education in endodontics to maintain my competence.	1	2	3	4	3.1±0.6	2-4	0.011*	0.172	0.639	0.563
Self-perceived competence						28.3±4.3		0.702	0.533	0.028*	0.372
Self-efficacy						27.5±4.3		0.828	0.751	0.413	0.375

To analyse the separate questions, Mann-Whitney U tests were used. To analyse the variables self-perceived competence and self-efficacy, Independent Samples T-tests were used
*P≤0.05.

all succeeded in the summative assessment. The performance of the participants in performing root canal treatment was in accordance with that of students of other dental schools around the world - of whom the reported 'acceptable' quality of root canal treatments varied between 23% and 79% (13-20) - and was not related to their self-efficacy or self-perceived

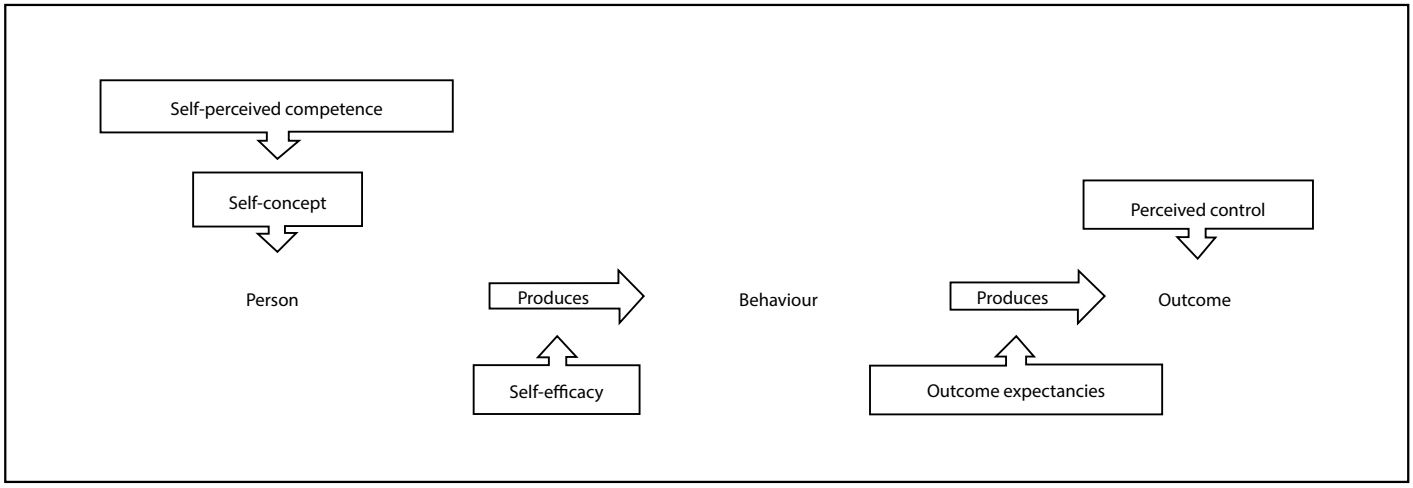

Figure 1. Diagrammatic representation of the process on which self-efficacy and self-perceived competence act. A person's outcome expectancies are their beliefs that certain behaviour will cause a certain outcome (2) A person's self-efficacy is their belief that they are able to fulfil the behaviour necessary to achieve an intended outcome (2) Perceived control is a person's belief that they can influence an outcome. Self-concept is a person's idea of the self, based on the beliefs one holds about oneself and the responses of others. Self-perceived competence is assumed to be part of self-concept; it is expected to represent a person's belief in their competence

competence. Exaggerated findings of self-efficacy or self-perceived competence because of overconfident students who might think that they are competent while they are actually incompetent are thus not expected in this sample.

The influence of undergraduate endodontic education on the students' perception of preparedness for performing endodontic treatment was measured differently in several previous studies (3-8). In the absence of a gold standard, a new questionnaire was composed for the present study to survey students' perception of their competence and their confidence. The internal consistency of this Endodontic Self-Perceived Competence Scale seemed good: Cronbach's alpha=0.818. For the dependent variable 'self-perceived competence', statistically significant differences were found between some of the independent variables. Among the answers to the separate questions of the scale, statistically significant differences were found as well. The Endodontic Self-Perceived Competence Scale seems to be a reliable test.

Determining the quality of a root canal treatment through interpreting periapical radiographs is arguable. Regarding interpreting periapical radiographs, the intra-observer reliability of observer one was almost perfect (κ=0.91), of observer two it was moderate (κ=0.55); the inter-observer reliability was moderate (κ=0.48) as well (21). It is known that the agreement between observers is in general low (22, 23). Unfortunately, in clinical endodontics, respecting ethical grounds, we do not really have better alternatives. Besides, this method for determining the quality of root canal treatments is often used in endodontic research and practice, and there is evidence that the quality determined this way is related to the outcome of a root canal treatment (24, 25).

The intermediate cohort of students was limited in size, and in case of convenience sampling, like here, it is unknown whether the participants represented the population well. Therefore, drawing firm conclusions regarding these data is avoided.

No one estimated his or her endodontic skills to be completely equal to those expected of a general dental practitioner (Table 1, question 5). That may reflect feelings of unpreparedness, which in their turn may be caused by lack of confidence, even though the answers to the questions regarding how competent the students felt were more favourable (Table 1, questions 1-4). This difference might indicate that students who are about to graduate have higher expectations of a general dental practitioner's skills than they do of their own. To graduates, this may be an incentive to continue learning and improving their skills. Moreover, no student denied completely the need for extra education (Table 1). Altogether, this fits the underlying principle of the Undergraduate Curriculum Guidelines for Endodontology of the European Society of Endodontology (ESE guidelines) that: 'a minimal level of competence is reached prior to graduation and that an ethos of continuing professional development is instilled in the graduate' (26).

The relationship found between the performance of students in performing root canal treatment and their answer to the question 'I know how to manage complications that may occur while performing endodontic treatment' might be explained by the influence of feedback. Especially in situations where students are aware that they perform below the norm, their feelings of confidence in their performance decrease (27). The assessed root canal treatment to determine students' performance was presumably one of the last endodontic treatments the student performed before completing the questionnaire and thus might have influenced the students' answers. The way the quality of the root canal treatment was determined in the present study was based, among other criteria, on the occurrence of ledges, perforations, transportations or instrument separation, which are all considered 'complications'. If one of

those complications occurred, the quality was determined as 'poor'. A recently experienced complication while performing a root canal treatment which caused a 'poor' result might have lowered the student's feelings of knowledge about managing those complications (28).

The increased self-perceived competence of students who attended the revised theoretical training module might have been due to vicarious learning. During the weekly tutorials given over a trimester, numerous as well as various cases can be discussed. This adds knowledge; one can learn from the experiences of another, and tutoring by endodontists may add credibility. Fellow students are good role models to increase feelings of preparedness: 'if they can do it, I can do it'. Moreover, imagining or watching another person's actions activates the same neural structure of the brain as performing the same actions oneself (29). Amplification of knowledge and skills presumably motivates a person to perform (2).

Students who attended the revised clinical training module reported a lower need for extra education in endodontics to maintain their competence than students who attended the former module and trained their clinical skills exclusively by performing endodontic treatment on patients. Consequently, the simulated component of the clinical training module seemed of added value to students. A possible explanation for this finding can be the 'safer' clinical environment the simulated component of the clinical training module provides. The students have there the possibility to perform root canal treatments in a variety of teeth with differing anatomy and difficulty in a clinical environment without the risk of iatrogenic damage on a patient. The number of available patients with suitable cases is decreasing, and, more importantly, risks to patients should be minimised. To overcome the influence of limited resources, the quality feedback by endodontists with their comprehensive knowledge of endodontics might increase students' feelings of competence (26). Self-efficacy increases not with the total number of experiences but with the number of successful ones (2).

In the ESE guidelines, no recommendations are made on the number of root canal treatments an undergraduate dental student should perform before graduation (26). Based on the findings in the present study, it might be recommended that before graduation students should perform at least three root canal treatments on patients, preferably under supervision of an endodontist.

Self-efficacy, determined with the use of the Endodontic General Self-Efficacy Scale described here, seems to be a useful outcome measure to evaluate the effectiveness of any given method of teaching endodontics. Accordingly, the goal of endodontic education should be improving not only the students' skills but also their self-efficacy. Future research should use the Endodontic General Self-Efficacy Scale on larger populations, to study which method of teaching endodontics provides students with the appropriate skills as well as the highest self-efficacy.

CONCLUSION

Within the limitations of the present study, it might be concluded that the method of teaching endodontics can influence the self-efficacy and self-perceived competence of undergraduate dental students. Among the modules and their components assessed in the present study, only the number of tutorials and the number of root canal treatments performed under supervision of the endodontists influenced the self-efficacy and the self-perceived competence of students.

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