

Article

Perceptions of Digital Competency among Student Teachers: Contributing to the Development of Student Teachers' Instructional Self-Efficacy in Technology-Rich Classrooms

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Academic Editor: James Albright

Received: 5 September 2016; Accepted: 5 February 2017; Published: 10 February 2017

Abstract: Adequate self-efficacy is useful for motivating individuals to engage in continued improvement. This study explores the potential antecedents of instructional self-efficacy beliefs among Norwegian student teachers attending a programme for secondary school teachers. The most important finding was the strong association between the student teachers' perceptions of digital competency to resolve challenges relating to information and communication technology (ICT) in schools and their instructional self-efficacy, which was explored via two dimensions: (1) self-efficacy for maintaining discipline and (2) self-efficacy for influencing students' use of ICT in the service of learning. Implications for practice are discussed. We argue that digital competency among student teachers is important for sustaining instructional self-efficacy in technology-rich classrooms.

Keywords: instructional self-efficacy; student teacher; teacher education; technology-rich classrooms

1. Introduction

Teacher education institutions are intended to prepare student teachers for professional life as teachers. Ideally, this should involve ensuring that teachers develop digital competence through on-campus classroom and teacher-practice experiences [1]. However, many educators in the field believe that teachers are not being adequately prepared to use technology for instruction [2]. This lack of adequate training puts teachers at a disadvantage, leaving them to enter the field with negative or non-existent perceptions of their efficacy in using educational technology [3]. Therefore, we must ask: to what extent does teacher training prepare student teachers to manage a classroom and motivate pupils' desire to learn in technologically dense surroundings that offer opportunities for off-task behaviours? The focus of this research is the preparation done in schools and universities. Teacher education programmes in many countries are based on national curricula, which typically emphasise either digital competence [4] or any of several related concepts, such as 'technological pedagogical content knowledge' [5], 'teachers' digital competence' [6] or 'professional digital competence' [7].

In the digital age, teacher education programmes are generally expected to prepare students for their professional activities in schools [8]. This preparation takes place in two arenas [9]: (1) on-campus teaching and (2) teaching-practice periods, during which student teachers experience life as teachers under the supervision of a mentor (and with periodic feedback from the university's teacher educators). This article focuses on Norwegian teacher education.

Student teachers often have low feelings of mastery during their first attempts to teach during their teaching practice [9], especially in technology-rich classrooms [10]. The reality they often encounter is a classroom in which the students have extensive access to mobile phones, computers or tablets with

Internet connections. Non-academic use of personal computers (PCs) in these classrooms is common, as students frequently keep several windows open and can easily switch among them [11]. In a survey, 56.6% of students at an upper secondary school reported that their teachers did not know what they were doing with their computers [3], and many students are experienced at quickly switching to an academic window when a teacher is near [12]. Research also shows that student teachers often feel inadequately prepared to effectively use technology in their classrooms [10,13]. However, to be effective, student teachers must be capable of tackling technological situations as they arise and persuading students to work conscientiously with curriculum materials when using digital aids [14].

One prior study of teacher instructional self-efficacy shows a curvilinear progression [15]: the sense of mastery increases with experience (though, remarkably, may decrease again after many years of teaching). The same pattern is observed in studies of teachers' 'value added' contributions to student performance [16]: though the number of years of teaching experience is positively associated with performance, teachers' value added contributions plateau after several years of experience before dropping slightly. In other words, instructional self-efficacy and value added contributions increase during a teacher's first years, and teachers are demonstrably more effective in their second year than in their first [17]. Many student teachers, however, never complete the teacher education programme [18], and many candidates leave the teaching profession during their first few years of work. To some extent, these trends are statistically associated with the student teachers' degrees of experienced self-efficacy [19].

Student teachers with low self-efficacy may lack the initiative or motivation needed to improve or may leave the field altogether. Thus, we can infer that mastery and self-efficacy are useful for motivating individuals toward continued improvement. It is, therefore, worth studying the factors associated with variations in instructional self-efficacy in technology-rich environments. We examine two dimensions of instructional self-efficacy: (1) self-efficacy for influencing student use of information and communication technology (ICT) in the service of learning and (2) self-efficacy for maintaining discipline in a heavily technological classroom. Skaalvik and Skaalvik [20] claimed that teachers encounter challenges in both dimensions of instructional self-efficacy. Therefore, this study explores the potential antecedents of student teachers' self-efficacy beliefs along both dimensions at a programme for secondary school teachers at a Norwegian university.

2. The Context

In most national systems, teacher education is a rather complex programme comprising both a degree in an academic subject (e.g., mathematics, chemistry, physics, history, political science) and pedagogic education, which more directly prepares the student for professional life in a school context [21]. To be accepted into a teacher programme at a Norwegian university, a student teacher needs to have completed adequate preliminary education (i.e., a master's degree in an academic/school-relevant subject and one year of studying in another academic or school-relevant subject). The combination of an adequate academic education and practical-pedagogical training forms the qualification for teaching years 8 to 13 in Norwegian schools. This practical-pedagogical training combines campus teaching and practical training in a school.

This study focuses on student teachers of lecturer programmes (i.e., programmes for teaching years 8 to 13) at a Norwegian university. The courses in pedagogy and subject-based didactics include a minimum of 60 days of teaching practice. This teaching practice is mentored, assessed and varied and can be carried out either individually or in groups. The time spent on individual or peer teaching is typically at least eight teaching hours per week. Ideally, the student teachers provide instruction on subjects they are qualified to teach. It is normal for two to four Norwegian student teachers to practice as student teachers in at least two schools (generally covering different levels within the school system, such as lower and upper secondary) during intense practice periods [22]. For full-time students, the practical-pedagogic training consists of two half-year terms (one year in total), and the legally required teaching practices are divided such that half fall into each term. During the final term, students have a

longer teaching practice, which is assessed by means of a final practical examination (an assessment graded as pass/fail). The individual teaching institution, in collaboration with the field of practice, sets routines for quality assurance and practice assessment.

Teaching practice is carried out in accredited schools. Most student teachers in the Norwegian teacher education programme complete their field experiences in technology-rich secondary schools. Upper secondary students in Norway usually have access to digital resources during their lessons, and access to computer technology is also increasing among lower secondary schools. Schools accredited for teaching practice collaborate formally with the teacher education institution through their governing bodies (which, in Norway, is a local authority or county council). The teacher education institution maintains close contact with the practice school. Practice mentors are expected to have experience and qualifications in the academic (research and teaching) field and in practice mentor training; however, in reality, this prerequisite is sometimes dropped. Practice mentors are employed by both the practice schools (mentors) and the university teacher-training institutions (teacher educators).

It is a recognised problem that the theoretical language of teacher training is only sometimes used in practice schools [23]. This phenomenon contrasts sharply with the practical training of medical students in hospitals, where students' academic language is also the professional language [24]. One way of addressing this problem is to offer mentor training to mentors in practice schools [25]. Currently, only some of the mentors who guide student teachers in their teaching practice possess such training. Since there is such a great need for newly trained teachers in Norway [26], authorities encourage relatively large groups of students to take teacher education programmes. As a result, Norwegian university teacher training institutions struggle to find adequate numbers of practice places for their student teachers, and practice places must often be found in schools that lie a considerable distance from campus. In the practice schools, it is also often a challenge to persuade teachers to mentor student teachers. Some teachers feel negatively about accepting such mentoring roles because the act of mentoring can disturb students' learning processes during examination terms, and disruptions in instruction caused by the less skilled efforts of a student teacher may weaken students' learning processes.

2.1. Theoretical Framework

Bandura [27] introduced the concept of self-efficacy beliefs as a self-assessment of a person's capabilities to attain a desired level of performance in a given endeavour. Bandura assumed that belief in one's abilities was a powerful driving mechanism influencing motivation to act, the effort put forth in the endeavour and the persistence of coping mechanisms in the face of setbacks. Several scholars have applied this theoretical framework to student teachers' practice [28].

Scholars inspired by Bandura have proposed several possible influences on student teachers' self-efficacy beliefs, including mastery and vicarious experiences [28]. Mastery experiences, which may have powerful impacts, stem from student teachers' actual teaching experiences with students [29]. Self-efficacy beliefs reflect student teachers' perceptions of their teaching achievement; if these beliefs are positive, future performances are more likely to be proficient.

Campus-based instruction during the student teacher programmes should form a foundation on which the student teacher can develop a mastery of technology use in teaching situations [30]. For instance, a clear goal of teacher education is to impart to student teachers 'advanced digital skills and the ability to make use of relevant digital tools and resources in the service of teaching in all subjects and to be able to assess and make use of developments in technology and media and guide children in their everyday use of digital tools' [1]. The foundation on which to build such skills is campus teaching in a teacher-training programme.

Current teacher-training programmes, however, have received extensive criticism, which has suggested that 'the development of professional digital skills is consistently weakly implemented in teacher training' [1]. Some people have cast doubts on whether those teaching such courses have the skills to develop campus-based instruction in subject didactics and pedagogy in a manner that

will promote professional digital skills among student teachers [31]. Criticism of teacher-training institutions has also been severe, and authorities have pointed to a lack of relevance for professional practice [1]. One empirical question is, 'to what extent does the teacher-training institution provide student teachers with a basis on which to develop professional digital skills that they can use to master teaching in a technology-rich classroom?' Nevertheless, we suggest that student teachers' experience and knowledge of digital teaching aids are related to their self-efficacy.

A student teacher's goal for taught lessons is for the students to follow the curriculum and work in a committed manner to achieve set tasks [9]. However, students may prefer to work in a more autonomous manner. Students in the Norwegian educational context are comfortable articulating their own needs for self-expression and feel a need to follow their goals [32], which may sometimes conflict with the student teacher's goals for teaching. This conflict can make teaching sessions demanding, particularly as student teachers tend to have a sense and understanding of the limitations of their positions in teaching situations. We therefore investigate the connections between perceptions of the inadequacy of the teacher role and two dimensions of teacher self-efficacy: maintaining order and discipline and fostering student engagement. The following shows the derived hypotheses.

Hypothesis 1. *Vicarious experiences (abbreviated ea) are positively related to instructional self-efficacy (sem).*

Hypothesis 2. *Positive attitudes (dcbb) are positively associated with instructional self-efficacy (sem).*

Hypothesis 3. *Student teachers' perceptions of digital competency (cse) are positively related to their instructional self-efficacy (sem).*

Hypothesis 4. *Student teachers' vicarious experiences (ea) are positively related to their perceptions of digital competency (secm).*

Hypothesis 5. *Perceived teaching constraints are negatively related to student teachers' instructional self-efficacy (sem).*

Below we explain the deduction of hypotheses. Vicarious experiences are those in which a target activity is modelled by other persons, such as mentors or teacher educators [33]. The impact of the modelled achievement on a student teacher's self-efficacy beliefs depends on the degree to which the student teacher identifies with the model [34]. When a model with whom the student teacher closely identifies performs well, the self-efficacy of the student teacher is enhanced. In the information and communication technology (ICT) context, student teachers tend to have personal experience with the technologies they are expected to use [35], since present-day student teachers are generally highly competent technology users [36]. This reasoning leads to Hypothesis 1.

Positive attitudes towards computers are positively correlated with teachers' levels of experience with computer technology and are recognised as a necessary condition for the effective use of ICT in the classroom [31]. This reasoning leads to Hypothesis 2.

Collective teacher efficacy involves teachers' perceptions of the school staff's efforts as a whole [37]. Collective teacher efficacy is a neglected construct in the study of schools, but it is used in studies of antecedents of individual instructional self-efficacy. Today's teachers collaborate by discussing and planning their teaching [38], and student teachers learn during their field experiences that teachers are expected to collaborate on and carry out a number of tasks as a team [39]. It is normal for two to four Norwegian student teachers who have one or two academic subjects in common to practice as pre-service teachers in at least two schools (generally covering different levels within the school system, such as primary and secondary) during intense practice periods. A typical student teacher will experience demanding teaching situations during his or her practicum. In such situations, interpersonal support from fellow students may be important for ensuring that experiences gained during the teaching practice contribute constructively to personal growth as a teacher. Because

collective attitudes towards solving challenges may have a supportive function for student teachers struggling with teaching matters, it is assumed that perceptions of digital competency among student teachers may contribute to their levels of belief regarding their own capabilities. Though generational differences exist in teachers' levels of resistance to using digital aids in teaching [40], young student teachers are typically considered to be digital natives regarding technology use [34]. Furthermore, the schools in which student teachers carry out their teaching practice are generally well-equipped with technological equipment, and many Norwegian students have PCs in their classrooms [41]. In other words, student teachers have ample opportunity to gain experience in the use of ICT in teaching.

Student teachers are also likely to work both alone and with other teachers and student teachers in their research and their experience-based approaches to practice work in their practice schools [9]. To our knowledge, perceptions of digital competency among student teachers have not yet been included in analyses of the antecedents of student teachers' instructional efficacy in technology-rich classrooms. Scholars have identified several constraint factors that affect student teachers' possibilities for action [42]. We explore how student teachers' perceptions of the limitations of what can be achieved through education concerning students' behaviour (which may induce arousal) are associated with their efficacy (including self-efficacy for maintaining discipline, self-efficacy for influencing students' use of ICT in the service of learning and perceptions of digital competency).

A student teacher's first experiences of teaching can be stressful. The teaching situation is complex, and, in the absence of prior experience, a student teacher needs to consider many factors simultaneously, which can easily lead to working memory overload and stress [43]. With experience, teachers become able to act more automatically, thus reducing cognitive overload [44]. To reduce this pressure, student teachers can engage in detailed planning and think through possible situations that may arise. While survival is the primary goal of a student teacher's first teacher-practice periods [42], an increasing level of experience gradually points students and newly qualified teachers towards understanding how learners are actually learning as a result of their teaching [9]. This shift occurs at the same time that the student or newly qualified teacher is reinforcing and consolidating his or her teaching repertoire [45]. The process constitutes a strengthening of teacher efficacy and is considered to be a positive sign of an individual's professional development in his or her teaching role [46]. Since the prognosis in Norway points towards a future shortage of teachers [26], it is important to investigate which factors are statistically associated with student teacher efficacy. This reasoning leads to Hypotheses 3 and 4.

Within Europe, Norway is among the countries with the greatest technology accessibility in schools [41]. Many schools maintain libraries of PCs and tablets that students are able to borrow. Since the technology is purchased and made available, local authorities and county councils often expect that it be used in teaching and become dissatisfied if it is used too little. Thus, Norwegian society has expressed a clear expectation that teaching should be modernised and that students should use technology in their learning. At the same time, however, students use technological devices, such as PCs and mobile phones, for purposes other than ones in accordance with the teacher's directions to support their learning. Therefore, classroom technologies also have the potential to create distraction [47]. To address this risk, teachers and student teachers may place restrictions on students' use of technology to ensure that the students follow class rules and to prevent them from being distracted by peripheral content on the Internet [48]. Such cases are examples of teachers creating boundaries for student behaviour. However, despite these challenges, student teachers should have more proactive attitudes towards the use of technology in teaching; they should find ways to motivate students' desire to learn [49], make students believe that they can learn better by using digital learning aids and persuade them to work diligently on their curriculum [50]. This reasoning leads to Hypothesis 5.

2.2. Methods

To answer our research questions, we conducted a survey of student teachers who had recently completed their long teacher-practice period and were writing reports on their experiences.

3. Participants

The data collection was carried out among students following the student teacher programme at a Norwegian university. These students' specialisms were studies of humanities, social sciences, mathematics and natural sciences. Firstly, items were explored in a pilot study where alternative items were discussed among student teachers before selecting items. Secondly, the student teachers completed a questionnaire in connection with a compulsory seminar. All of the students opted to participate. The survey was carried out amongst 104 Norwegian student teachers during the autumn of 2015.

4. Data Sources

We designed our cross-sectional survey as a questionnaire to administer to student teachers during their last year of the teacher training programme, after they had completed their eight-week field experience. The questionnaire asked the students to recall the extent to which they considered their studies relevant to teaching practice and to describe their experiences. The questionnaire was constructed based on acknowledged measurement instruments previously reported in the literature (adapted from [51]) and as a new development on attitudes. Though a number of instruments exist [52] and have been used in studies of student teachers' reactions to technology use in teaching, we felt that none of these were well suited to our research ambition (the construct, 'Competencies to support pupils for ICT-use in class' [53] partly overlaps our construct, 'Self-efficacy for influencing the pupil's use of ICT in the service of learning'), as the dimensions seemed not to centre on student teachers' field experiences in technology-rich environments. Thus, we chose to use instruments designed for the particular goals of our survey.

Our description of the context was as follows:

'Imagine that you have been given a temporary job as a teacher at a school. The school leadership has determined that each student should have his or her own computer with an Internet connection and unrestricted Internet access during your lessons.'

In the survey, the student teachers responded to items on a seven-point Likert scale ranging from one (low) to seven (high), with four representing a neutral midpoint. The concepts were measured with two to three single items. The analysis reported in the following is based on five measurement instruments. The internal consistency (Cronbach's alpha) was estimated for each of the concepts. The student teachers were asked to give answers to the following questions.

Self-Efficacy for Maintaining Discipline (Secm), $\alpha = 0.89$

How certain are you that you can:

- persuade even the most gaming-interested students to concentrate on school-related tasks? (Item No. w3)
- persuade students who often switch among different social media to follow classroom rules? (w4)
- persuade all students to concentrate on educational tasks without being disturbed by other Internet-based material? (w5)

Self-Efficacy for Influencing Students' Use of ICT in the Service of Learning (Sem), $\alpha = 0.79$

- Using digital aids, to what extent can you motivate students to have a real desire to learn? (w12)
- To what extent can you persuade students to believe that they can learn better by employing digital learning resources? (w13)

- To what extent can you persuade students to work hard with curriculum materials when they are using digital resources? (w14)

Prospective Perceptions of Digital Competency to Resolve Challenges Relating to ICT in Schools (Cse), $\alpha = 0.72$

At this school, the teachers:

- effectively prevent digital bullying on school premises. (w16)
- handle any problems that arise with ICT as a learning resource because we work as a team. (w17)
- create a safe atmosphere even in the most challenging classes. (w18)

Constraint Factors: Perceptions of Student Self-Determination in Using ICT (Dcb1), $\alpha = 0.82$

- The amount that students learn at school by using ICT is determined primarily by their motivation. (w25)
- The amount that students learn at school by using ICT is determined primarily by their self-discipline. (w26)

Vicarious Experience Understood as Enactive Attainment (Ea), $\alpha = 0.38$

- To what extent have you gained experience during teaching-practice periods with teaching resources containing pictures, illustrations, video clips, animations and audio fragments? (w29)
- To what extent have you gained knowledge through the teacher-training course about teaching resources containing pictures, illustrations, video clips, animations and audio fragments? (w30)

Attitudes Towards Digital Skills (Dcbb), $\alpha = 0.79$

- The focus on digital skills in this school has contributed to reinforcing students' academic learning. (w36)
- The focus on digital skills in this school has resulted in appropriate contemporary education. (w38)
- The focus on digital skills in this school has been a deviation (reversed). (w39)

4.1. Results

Table 1 shows the descriptive statistics of the items used.

Table 1. Items' means, standard deviations, minimum and maximum scores, skewness and kurtosis.

Item	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
w3	1.00	6.00	3.24	1.46	0.20	−0.88
w4	1.00	7.00	3.63	1.47	0.00	−0.76
w5	1.00	6.00	3.13	1.46	0.26	−0.85
w12	1.00	7.00	5.02	1.10	−0.85	2.46
w13	1.00	7.00	4.64	1.25	−0.41	0.49
w14	1.00	7.00	4.39	1.10	−0.30	0.04
w16	1.00	7.00	3.43	1.46	0.37	−0.18
w17	1.00	7.00	4.42	1.36	−0.15	0.11
w18	1.00	7.00	4.45	1.16	−0.30	0.01
w25	1.00	7.00	4.63	1.41	−0.35	0.06
w26	1.00	7.00	4.95	1.44	−0.52	−0.05
w29	1.00	7.00	5.77	1.27	−1.55	2.69
w30	1.00	7.00	4.28	1.48	−0.29	−0.75
w36	1.00	7.00	4.23	1.13	−0.18	0.51
w38	1.00	7.00	5.04	1.37	−0.78	0.46
w39	1.00	7.00	5.19	1.62	−0.81	−0.23

Structural equation modelling, which is suitable for confirmatory factor analysis and path analysis, was used to analyse the relationships among the variables [54]. To address measurement errors in the analysis, the structural models were designed to include the measurement models. If we had conducted an exploratory factor analysis and used factor scores instead of latent variables in the structural equation modelling (SEM) analysis, the measurement errors would have influenced the estimation to a greater extent.

The assessments of the fit between the model and the data are based on the following indices: root mean square error of approximation (RMSEA), Tucker-Lewis index (TLI), goodness-of-fit index (GFI) and comparative fit index (CFI). RMSEA <0.05 and TLI, GFI and CFI >0.95 indicate a good fit, while RMSEA <0.08 and TLI, GFI and CFI >0.90 indicate an acceptable fit.

The measurement and structural models were estimated using IBM SPSS Amos 22. The RMSEA, TLI, GFI and CFI values indicate an acceptable fit for the structural model in Figure 1. The ovals represent the latent variables, the circles represent the measurement errors and the rectangles represent the observed measured variables. The structural model consists of terms with paths (arrows) between them. The path arrows indicate theoretical common causes, and the figures (standardised regression coefficients) reflect the measured strengths of the connections. Strength increases with the numerical value.

Figure 1 shows the estimated structural model in which self-efficacy for influencing students’ use of ICT in the service of learning and self-efficacy for maintaining discipline are the dependent variables. While the model is substantially relevant, the loadings of items linked to enactive attainment are not fully satisfactory. Further, the item ‘To what extent have you gained experience during teaching-practice periods with teaching resources containing pictures, illustrations, video clips, animations and audio fragments?’ (w29) has high skewness and kurtosis. Therefore, the construct ‘Vicarious experience understood as enactive attainment’ (abbreviated ea) was split into two single items, on which we ran new SEM analyses (Figures 2 and 3, Table 2).

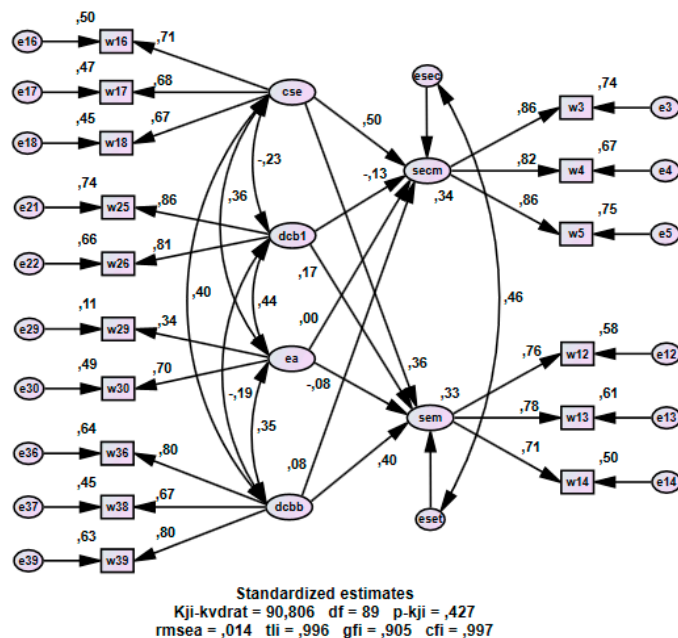


Figure 1. Structural equation modelling. Abbreviations: secm = self-efficacy for maintaining discipline; sem = self-efficacy for influencing students’ use of information and communication technology (ICT) in the service of learning; cse = perceptions of digital competency among student teachers or ‘teacher collaboration to resolve challenges relating to ICT in schools’; dcb1 = perceptions of student self-determination in using ICT; ea = enactive attainment; dcbb = attitudes towards digital skills.

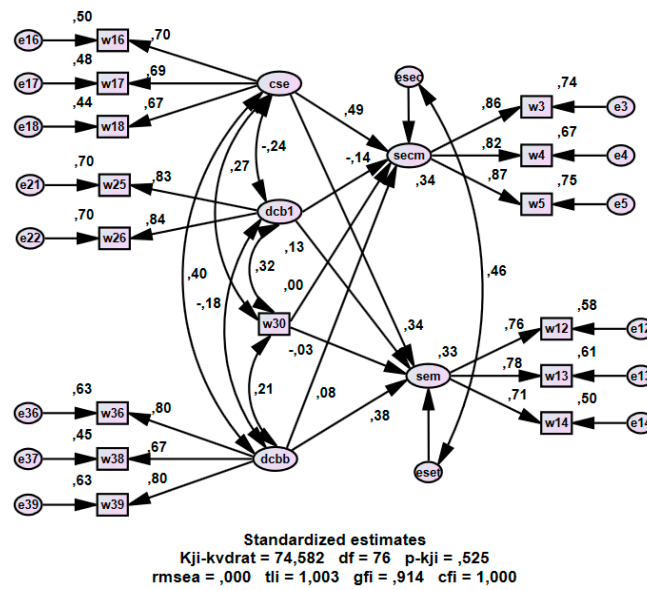


Figure 2. Structural equation modelling. Abbreviations: secm = self-efficacy for maintaining discipline; sem = self-efficacy for influencing students’ use of ICT in the service of learning; cse = perceptions of digital competency among student teachers or ‘teacher collaboration to resolve challenges relating to ICT in schools’; dcb1 = perceptions of student self-determination in using ICT; dccb = attitudes towards digital skills. Item 30 is: ‘To what extent have you gained knowledge through the teacher-training course about teaching resources containing pictures, illustrations, video clips, animations and audio fragments?’

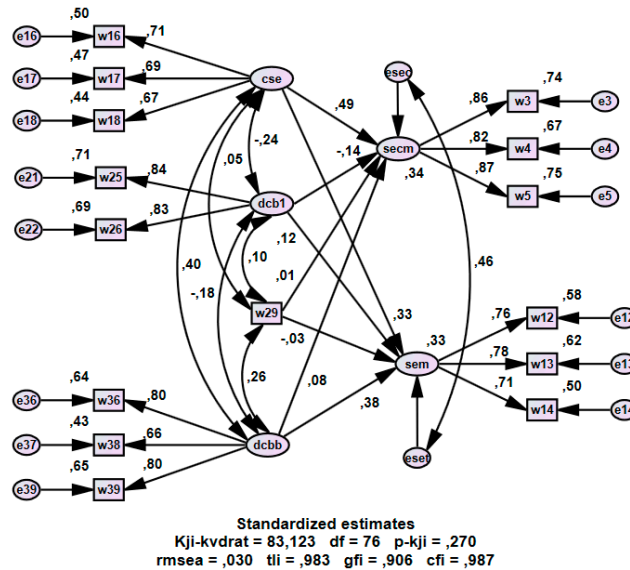


Figure 3. Structural equation modelling. Abbreviations: secm = self-efficacy for maintaining discipline; sem = self-efficacy for influencing students’ use of ICT in the service of learning; cse = perceptions of digital competency among student teachers or ‘teacher collaboration to resolve challenges relating to ICT in schools’; dcb1 = perceptions of student self-determination in using ICT; dccb = attitudes towards digital skills. Item 29 is: ‘To what extent have you gained experience during teaching-practice periods with teaching resources containing pictures, illustrations, video clips, animations and audio fragments?’

Table 2. Hypotheses and results.

Hypothesis	Wording	Result
1	Vicarious experiences are positively related to instructional self-efficacy.	The associations between these variables in model 1 and model 2 are not significant and, thus, fail to support the hypothesis.
2	Positive attitudes are positively related to instructional self-efficacy.	The association ($b(\text{dcbb} \rightarrow \text{sem}) = 0.40$) in model 1 is significant and supports the hypothesis; however, the association ($b(\text{dcbb} \rightarrow \text{secm}) = 0.08$) is not significant.
3	Perception of digital competency among student teachers is positively related to instructional efficacy.	The association ($b(\text{cse} \rightarrow \text{sem}) = 0.36$) in model 1 is significant and supports the hypothesis. The association ($b(\text{cse} \rightarrow \text{secm}) = 0.50$) in model 1 is significant and supports the hypothesis.
4	Vicarious experiences are positively related to perceptions of digital competency among student teachers.	The associations ($b(\text{ea} \rightarrow \text{secm}) = -0.00$) and ($b(\text{ea} \rightarrow \text{sem}) = -0.08$) are not significant and do not support the hypothesis.
5	Constraint factors are negatively related to instructional efficacy.	The association between these variables in model 2 is not significant and, thus, fails to support the hypothesis.

4.2. Discussion

The *raison d'être* of teacher education is to qualify student teachers for their working life as teachers [21]. The value added by a teacher education programme is related to the quality of its campus-based courses, the student teachers' talent for carrying out the tasks associated with the teaching profession, the quality of the mentoring received by the student teachers during their school-based practicum and the student teachers' learning activities [55]. The interrelationships among these factors are complex, and it is difficult to isolate the significance of any one individual factor in such a way as to provide unambiguous information about the quality of a teacher education programme [56]. Nevertheless, in this article, we restrict the scope to focus solely on the antecedents of student teachers' instructional efficacy.

Student teachers' attitudes towards students' digital skills are strongly associated with their self-efficacy for influencing students' use of ICT, but not with their self-efficacy for maintaining order and discipline. While weak associations were found between student teachers' enactive attainment and their instructional efficacy beliefs, we admit that the instrument used to measure enactive attainment did not function well. More research is, therefore, needed to better understand the relationships between student teachers' experiences during field practicums and teacher-training courses and digital teaching resources (i.e., resources containing pictures, illustrations, video clips, animations and audio fragments).

We observe a strong empirical relationship between student teachers' perceptions of digital competency and their self-efficacy for maintaining discipline. A moderately strong relationship exists between student teachers' perceptions of digital competency and their self-efficacy for influencing students' use of ICT in the service of learning. We can say that it is beneficial for a student teacher to experience teacher collaboration in the effort to solve ICT-related challenges within a practice school. This finding is supported by a long line of research that highlights the importance of the collective dimension of the teaching profession [57]. The first practice period might begin with a sheltered introduction to teaching practice; however, student teachers will find it easier to grow into their roles as leaders of learning processes if a reasonable balance exists between challenges and opportunities [58]. Viewed in light of its importance in reinforcing teacher efficacy, socialisation within school teaching staff is also an important factor [59]. We also argue that perceptions of digital competency among student teachers represent an under-recognised dimension of good teacher education. Teacher educators may stimulate perceptions of digital competency among student teachers by deliberately gathering small groups of students who have initially good relations during practice periods.

We also observe that perceptions of digital competency among student teachers have a moderately negative association with perceptions of student self-determination in using ICT and a strongly negative association with attitudes towards digital skills. It is also beneficial for student teachers to have positive attitudes towards the use of ICT, since this is positively associated with a sense of 'us' in field-based experience.

A strong positive association is evident between attitudes towards digital skills and self-efficacy for influencing students' use of ICT in the service of learning. However, no empirical association exists between attitudes towards digital skills and self-efficacy for maintaining discipline. The latter reflects the high demand placed on student teachers to handle classroom situations in technology-rich surroundings.

No empirical association was found between enactive attainment and self-efficacy for maintaining discipline or between enactive attainment and self-efficacy for influencing students' use of ICT in the service of learning. More research is required to understand the reason for this outcome; however, it could be suggested that student teachers lack an adequate foundation of knowledge to didactically interpret their academic subjects in teaching situations involving digital teaching resources. Another possible interpretation is that the main challenges for the student teacher lies less in using digital teaching resources and more in entirely different challenges, such as dealing with unruly students [60].

We observe moderately strong path coefficients between enactive attainment and attitudes towards digital skills, between enactive attainment and perceptions of student self-determination in using ICT and between enactive attainment and perceptions of digital competency among student teachers (teacher collaboration to resolve challenges relating to ICT in schools). The differences in the path coefficients between perceptions of student self-determination in using ICT and self-efficacy for maintaining discipline and between perceptions of student self-determination in using ICT and self-efficacy for influencing students' use of ICT in the service of learning are unclear, as the empirical association is not strong; however, it is certainly present. In other words, there are various currents within the associations between perceptions of student self-determination in ICT usage and self-efficacy for maintaining discipline on one hand, and self-efficacy for influencing students' use of ICT in the service of learning on the other. More research is required here to understand the full complexity of the issue.

We find a negative association between perceptions of student self-determination in using ICT and attitudes towards digital skills, although this association is not strong. This suggests that those with limited enthusiasm for ICT in schools are also realistic about students' abilities to follow teachers' instructions for working with digital resources.

4.3. Implications for Further Research

Criticism has been directed towards teacher-training institutions concerning the extent to which they adequately prepare student teachers during their campus-based instruction [1]. This is a particular challenge in the teaching of subject-based didactics within teacher training, as it is primarily within subject-based didactics that we find the concrete academic representations that illustrate how ICT can be integrated into teaching. A question that has not yet been raised concerns the modelling of teaching done by the mentor (since the student teacher first observes the mentor's teaching before making his or her first attempt) and the teacher educator: Specifically, how do their modelling and mentoring support student teachers' attempts to use ICT in teaching?

The literature regarding ICT in teacher training is widely optimistic regarding the opportunities created by technological advances [61]. Student misuse of digital aids (e.g., mobile phones, PCs, tablets) receives very little attention in the teacher-training curriculum (authors' observation). However, we do not know whether this discrepancy contributes to increased frustration amongst student teachers when they are first practicing their work in the field. Since all participants in our study were under 30 years of age, they can be considered digital natives based on their experience of society's digital revolution [62]. The question, then, is: to what extent does teacher training prepare student teachers to

manage a classroom and motivate students' desire to learn in technologically dense surroundings that offer opportunities for off-task behaviour?

4.4. Study Limitations

This study has several limitations from a conceptual perspective (parsimonious modelling) and in terms of its methodological (cross-sectional) approach. We acknowledge these limitations and argue that they can serve as points of departure for future research. One limitation of this study is its use of self-reported questionnaire data, as the subjective component of such data is undeniable. Additionally, the study examined only a limited number of concepts. Another limitation involves the sample of student teachers. While the survey's response rate was 100%, the participants came from only one teacher education institution. Therefore, we cannot be sure that our sample is representative of the whole population of students in the student teacher programme in Norway or elsewhere. The final limitation of the present research was the low reliability ($\alpha = 0.38$) of the enactive attainment scale. Researchers may wish to consider whether further refinements of the scale would enhance its reliability. In sum, the shortcomings of this study provide direction for future research.

5. Conclusions

Despite its shortcomings, this study may contribute to our understanding of the antecedents of student teachers' instructional self-efficacy. The most important finding concerns the strong association between student teachers' perceptions of digital competency and their instructional efficacy. The path coefficients were quite large for the associations between (1) student teachers' perceptions of digital competency and their self-efficacy for maintaining discipline and (2) student teachers' perceptions of digital competency and their self-efficacy for influencing students' use of ICT in the service of learning. This finding has implications for teacher education programmes. Perceptions of digital competency among student teachers may be important for nurturing student teachers' instructional self-efficacy in technology-rich classrooms via, for instance, sustained institutional arrangements. A typical student teacher will experience demanding teaching situations in a technology-rich school environment. In such situations, perceptions of regular teachers' ability to manage the technology use of their students may be important for ensuring that experiences gained during the teaching practice contribute constructively to student teachers' personal growth as teachers. Human support from other student teachers can also bridge a gap that can be only partially filled by practice mentors, who are engaged in assessing students' practice periods [9].

Acknowledgments: This research project was funded by a grant (218245) from the Norwegian Research Council. We thank three reviewers for their constructive and helpful comments.

Author Contributions: The authors have contributed equally.

Conflicts of Interest: The authors declare no conflict of interest. The study sponsors had no role in the design of the study; in the collection, analyses, or interpretation of the data; in the writing of the manuscript; or in the decision to publish the results.

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