3 Teachers' Integration of Technology: What Significance does the Subject Area have in Norwegian Schools?

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Abstract: Although schools have undergone a digital transformation, digitalization has not led to substantial changes in education. Despite extensive research on the use of digital tools in teaching, little is known about teachers' perceptions and use of technology in various subjects. Also, it is not clear why some subjects are more likely to integrate technology into teaching and learning. Based on a validated path model as a conceptual framework, this chapter presents an analysis of two subjects in education (Norwegian and Mathematics). The findings showed that the subject area had a significant impact on integration and had a main effect on teachers' beliefs. However, this effect on integration and beliefs was reduced when compared with multi-subject teachers' responses, indicating the special circumstances that characterize the Norwegian school context. Still, the multi-subject effects do not change the main pattern. This result shows that the subject areas are not homogeneous, and technology integration is decisively shaped by the subject areas, giving rise to the different patterns, which can provide a deeper understanding of teachers' technology integration in education.

Introduction

The digitalization of education is a global phenomenon, and this development is particularly evident in schools. Authorities in different countries have driven the development, and this is expressed in curricula and strategy documents, which include high expectations for better learning and learning outcomes (Selwyn, 2013). Although different countries have created their own national strategies for digitalization, these appear to be based on the common idea that technology can be integrated into education in a generic way, regardless of differences between different subject areas (Howard & Maton, 2011).

In Norway, the concept of digital competence has gained a central place in curriculum reforms (Erstad, 2010; Krumsvik, 2016), and they have stated that digital tools should be used in all subjects (LK06). Digital competence is a complex concept, but in the school context, the concept has been characterized as a key competence, which will enable teachers and students to use technology in education. Based on this, educational research has emphasized suitable approaches for developing teachers' and students' digital competence in digital school.

A number of studies are concerned with teachers being digitally competent, and there are a number of contributions that describe various elements that should be included in teacher's digital competence (Johannsen, Øgrim, & Giæver, 2014; Lund, Furberg, Bakken, & Englien, 2014). These studies have focused on the teacher's specific digital competence in school, which has contributed to the development of the concept of professional digital competence, a concept that incorporates academic and didactic dimensions, in which ICT should be based on educational objectives in the curriculum (Krumsvik, 2016).

Although the Norwegian school has undergone a digital transformation, with schools with rich access to technology, it has not resulted in a corresponding increase in the use of technology for educational purposes or significant changes in educational practices in the classroom (Blikstad-Balås, 2015; Hatlevik, 2013; Kopcha, 2012; Ludvigsen, & Rasmussen, 2006). Research shows that the use of technology is shaped by established pedagogical practices and that technology use can vary considerably between different subject areas (Arnseth, 2007; Hatlevik, 2013). The government's strategy (UFD, 2004; Kunnskapsdepartementet, 2017), with an emphasis on digital competence or literacies, has not led to the expected integration of technology in education. This may be due to a number of factors, but research has focused on elements related to teachers' specific teaching practices in various subject areas and has considered factors that may have a crucial impact on technology integration in education. Researchers recommend that teachers should be trained to use ICT in a didactic and subject-specific way (Kirshner et al., 2008), arguing that there is a need to develop digital didactics (Krumsvik, 2009). Others have suggested how teachers can use technology in different subject areas (Otnes, 2009). It is emphasized that the individual subject area, as it is designed in the curriculum, constitutes "a separate microcosm" (Goodson, & Mangan, 1995), with its own values and traditions. This insight indicates that teachers' perceptions and practices in various subject areas are key factors for integrating technology into education. However, it is not clear what is meant by the subjects being a separate microcosm.

Although research has gradually begun to emphasize the importance of the various subject areas, these are treated as differences in teachers' perceptions of pedagogies, content knowledge, and learning strategies (Law et al., 2008). While these are central elements of teachers' teaching practices, this type of conceptualization involves a superficial approach to the subject areas, focusing on learning instead of on knowledge and the principles underlying teachers' knowledge practices in separate subject areas (Howard et al., 2015). In this way, the connection between the elements that form teachers' pedagogical practices in subject areas and the underlying educational knowledge remains obscured, which leads to differences between different subject areas that are not clearly understood (Howard & Maton, 2011).

Based on the social and realistic theory, Bratland (2016) and Howard and Maton (2011) demonstrated how teachers' perceptions and practices in the subject area are shaped by underlying organisational principles, which affect how technology is integrated into subject areas. According to this approach, subject areas include various forms of knowledge, which consist of social and epistemic relationships with different strengths. In educational contexts, this determines teachers' perceptions of the subject area, what students need to know, and what kind of knower one needs to be. Teachers' subject area beliefs, based on the nature of the underlying relationships, impacts teachers' perceptions of what it takes to succeed in the subject area, how technology can best support student progress, and how important technology is in acquiring knowledge in a subject.

This research reveals how technology integration is related to teachers' subject area beliefs and why technology clashes or matches with different subject areas. Based on an analysis of the underlying relationships, Howard and Maton (2011) identify a possible clash between mathematics and technology integration, while in English, there is a possible match. This analysis shows how educational knowledge in the subject area helps structure the practices and perceptions of the teachers, and it is only when this perspective is applied that it becomes possible to explore the effect of subject areas on technology integration. Howard et al. (2015) point out that research still needs to explore the effect of subject area on integration and the specific factors that can highlight teachers' technology integration.

Digitalization in Norwegian Schools

The Norwegian authorities have carried out large-scale digitization in Norwegian schools. The digitalization initiative is based on ambitious plans (UFD, 2006; UFD, 2004; Kunnskapsdepartementet, 2017), and the implementation of the technology in schools has taken place at the county and municipality level. The authorities' digital initiative has resulted in more use of information and communication technologies (ICT) but has not led to significant changes in teaching practices or in teachers' technology integration (Hatlevik, 2013; Hatlevik & Kløvstad, 2009; Ludvigsen & Ramussen, 2006). Teachers' practices appear to be crucial for effective integration of technology (Tamim et al., 2011), but because teachers' practices vary between different subject areas, research needs to explore subject areas as a crucial factor for teachers' integration of technology into education (Howard et al., 2015; Inan, & Lowther, 2010). There is a lot of evidence that teachers' practices in the subject area are a key factor that influences teachers' perceptions and use of technology within the subject area (Ertmer & Ottenbreit-Leftwich, 2010).

At the same time, it is reasonable to believe that the subject's effect on teachers' practices cannot be seen independently of teachers' subject specialization, and whether the school structure allows teachers to teach in a single subject area, or whether they are required to teach in a number of subject areas. School structures vary between different countries, and the structure can open up or limit specialization and the division of labor. The Norwegian school system is characterized by a structure with relatively small schools, which to a lesser extent, allows specialization, where teachers, even in secondary school, are required to teach in a number of subjects. Previous surveys of Norwegian teachers' competence in central subject areas show that Norwegian schools have significant challenges (Carlsten et al., 2014; Lagerstrøm et al., 2014). Thus, the Norwegian teacher model is a factor that may have an impact on how Norwegian teachers integrate technology into education and could conceivably weaken the importance of subject areas as a factor for technology integration.

A Model for Technology Integration

There are several models developed to explore teachers' technology integration. Several of these models for research on technology integration are affected by the above-mentioned criticism, and an alternative path model should provide an opportunity to explore the effects of a subject area and teacher integration of technology. Inans and Lowther's (2010) model includes factors to explore the relationships between subject areas and technology integration. Howard et al. (2015) developed a path model for the relationship among variables (see Figure 1, adopted from Howard et al., 2015, p. 367).

This model examined the relationships between subject areas and factors that have previously been important for technology integration. Teacher readiness and teacher beliefs have been adopted from Inans and Lowther (2010) and are important factors for technology integration. Inans and Lowther define teacher readiness as teachers' perception of their capabilities and skills required to integrate laptops into classroom instruction, and teacher beliefs as "teachers' perception of laptops' influence on student learning and achievement and impact on classroom instruction and learning activities" (p. 939). Howard et al. (2015) added time into their model, which is an independent variable with the purpose of examining change over a number of years. In their study, this variable aims to shed light on whether participation in the organized laptop program would have a bearing on teachers' integration of technology over time. In the Norwegian context, there is no correspondingly organized laptop program, and

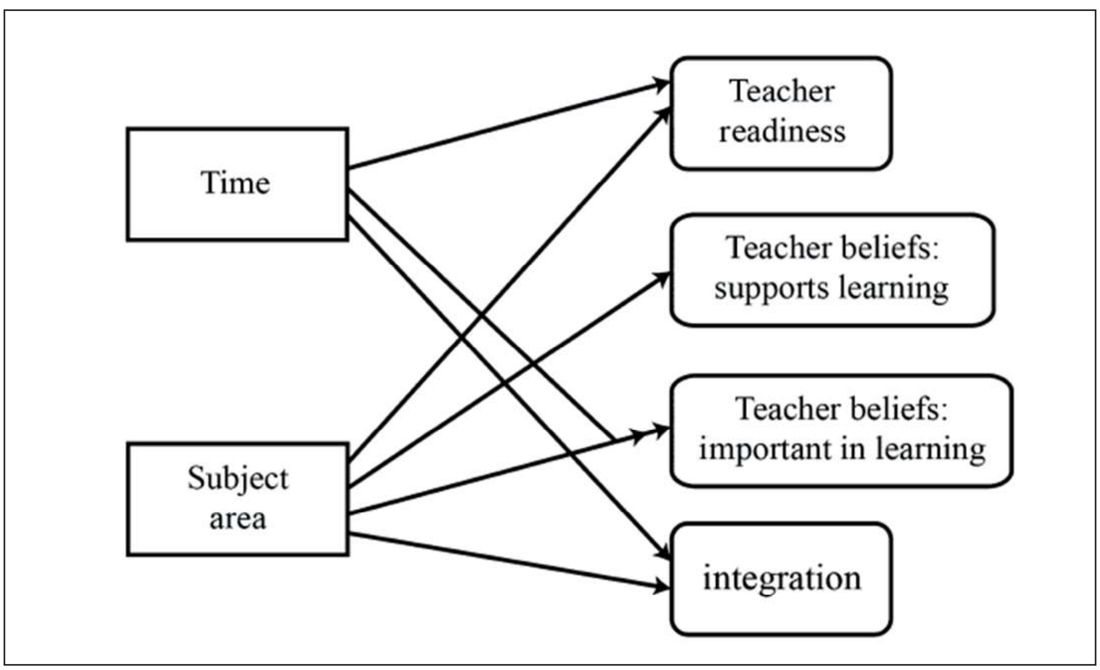

Fig. 1: Path model of teachers' technology integration.

this variable will be continued as a dependent variable that reveals the connection between subject areas and time spent using ICT in classrooms. Accordingly, this chapter explores the effect of the subject area on the variables mentioned. This proposed path model (see Figure 1.) is tested on a new data set, collected at schools in Northern Norway, and the discussion examines the effect of the subject area and whether this should be moderated or reformulated in the face of a Norwegian school context.

Method

This paper is based on the collection of data by an empirical survey among a number of schools in Northern Norway (Nordland, Troms, and Finnmark). The survey was an online questionnaire that explored teachers' perceptions of subject-area knowledge practices and technology integration. The participants of this study included 144 females (72%) and 56 males (28%) who were teachers of mathematics, Norwegian, English, science, and social science in fifth through tenth grade. The current study compares mathematics and Norwegian teachers' questionnaire responses on what they believe about the use of technology in teaching their main subject areas. The illustrative focus included a total of 122 teachers from mathematics ($n = 47$), Norwegian ($n = 45$), and both subjects ($n = 30$). They responded to the items in 2018–2019.

The analysis presented draws on a subset of 18 items from the teacher questionnaire. Items were selected for their alignment with variable descriptions from Inan and Lowther's model. The independent variables in this analysis were the subject areas of mathematics, Norwegian, and multiple subjects. Teachers were asked to respond in relation to their practices, as well as specify their primary content area of teaching. Table 1 presents the dependent variables as defined in Howard et al. (2015).

Tab. 1: The dependent variables

Variable	Description
Integration	Teachers' self-rating of how frequently they used a computer in teaching
Teacher readiness	Teachers' perceptions of their skill level and effectiveness using ICTs in teaching
Teacher beliefs: the importance of computers	Teachers' perceptions of how important it is for them to use computers in their work, as well as for students to use computers in their learning
Teacher beliefs: supports learning	Teachers' perceptions of how computers support student learning outcomes (e.g., creativity, organisation, understanding, etc.)

The instrument consisted of one scale for ICT integration in teaching and three subscales with acceptable reliability values: teacher readiness (5 items, = 0.77), teacher beliefs regarding the importance of computers (6 items, = 0.75), and supports learning

(6 items, = 0.78). The combined measure allocates equal weight to each subscale regardless of the number of items representing each subscale.

Results

The current study compares ICT integration in teaching among mathematics, Norwegian, and multiple-subject teachers. Table 2 and Table 4 present descriptive statistics for teachers' responses to each variable in the two subject areas. Table 5 presents the main analysis. All follow-up pairwise comparisons are with Scheffe adjustment controlling α at .05.

Results of the ANOVA indicated significant main effects of the subject area on the ICT integration in teaching $F(3, 148) = 8.852$, $p < 0.001$ (see Table 3). Mathematics and Norwegian teachers showed significant differences in how often they used computers in their teaching. This differences are presented in Figure 3, which indicates that Norwegian teachers in Northern Norway reported (see Table 2) more use of technology in classroom practices (M =2.04, SD = 0.90) than mathematics teachers (M = 1.42, SD = 0.65; $p < .001$). However, based on the multiple subject teachers' questionnaire responses, this gap was significantly reduced. Even though they reported positive ICT use in Norwegian (M = 1.60, SD = 0.67) compared to mathematics (M = 1.23, SD = 0.62; $p = 0.296 > 0.05$), this difference is not significant. The finding shows negative effects for ICT integration in the same subjects of the multiple subject group, and the pairwise comparisons between groups showed that multiple-subject teachers reported less ICT integration than mathematics teachers ($p > 0.74$) and less integration than Norwegian teachers ($p > 0.09$), though these differences are not significant (see Figure 2).

Tab. 2: ICT Integration in Teaching

	N	M	SD
Mathematics	47	1,425	,6509
Norwegian	45	2,044	,9034
Multiple subjects (Integration of ICT in Mathematics)	30	1,233	,6260
Multiple subjects (Integration of ICT in Norwegian)	30	1,600	,6746
Total	152	1,605	,7903

Note. Scale, 0 = 'Never'; 1 = '1–2 times a week'; 2 = '3–4 times a week'; 3 = '5–6 times a week'; and 4 = ' 7+ times a week'; M, mean; SD, standard deviation.

Tab. 3: Factorial ANOVA of the Independent Variable: ICT Integration in Teaching.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	14,349	3	4,783	8,852	,000
Within Groups	79,967	148	,540		
Total	94,316	151			

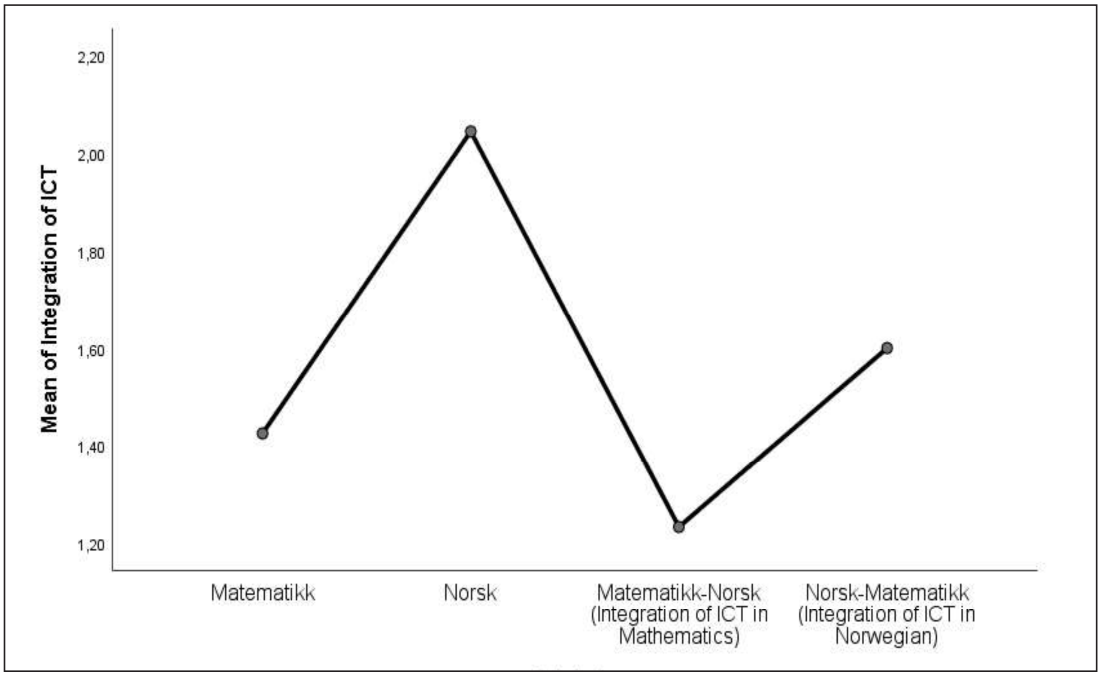

Fig. 2: Computer use in Northern Norway in mathematics (Matematikk) and Norwegian (Norsk).

The findings show that mathematics teachers' computer use in schools in Northern Norway is significantly lower compared to teachers' use of time in Norwegian. However, this effect is reduced when looking at the responses from teachers who teach multiple subjects. In regard to teacher readiness using computers, the analysis showed no main effects for subject area $F(2, 121) = 1.186$, $p = 0.309$ (see Table 5). Follow-up pairwise comparisons showed only a small, non-significant difference between the three groups. Mathematics teachers reported less confidence than teachers in Norwegian ($p > 0.72$) and multiple-subject teachers ($p > 0.31$).

For the two teacher beliefs variables: "ICT is important" and "ICTs support learning" (see Table 4), the findings show a main effect of the subject on teachers' beliefs that ICTs are important $F(2, 121) = 3.369$, $p < 0.05$ and that ICTs support learning $F(2, 121) = 4.420$, $p < 0.05$ (see Table 5). Norwegian teachers reported significantly more positive beliefs about the importance of ICTs than mathematics teachers ($p < 0.05$). Pairwise comparisons between groups also showed that multiple-subject teachers reported more, but not significantly more, positive beliefs than mathematics teachers ($p > 0.22$) and less, but not significantly less than Norwegian teachers ($p > 0.89$; Figure 3). For "ICTs support learning," the findings show that mathematics teachers in Northern Norway ($M = 2.90$, $SD = 0.426$) are significantly lower than Norwegian teachers ($M = 3.16$, $SD = 0.46$, $p < 0.05$). Similar to the teacher beliefs variable, "ICT is important," the pairwise comparisons between groups showed that multiple-subject teachers reported slightly more positive beliefs "ICTs support learning" than mathematics teachers ($p > 0.89$) and less than Norwegian teachers ($p > 0.12$), though these differences were not significant (see Figure 5).

Tab. 4: The main effect of the subject on teachers' beliefs that ICTs are important, and that ICTs support learning.

		N	M	SD
Teacher beliefs: the importance of computers	Mathematics	47	3,237	,483
	Norwegian	45	3,459	,402
	Maths-Norwegian	30	3,411	,360
	Total	122	3,362	,434
Teacher beliefs: supports learning	Mathematics	47	2,900	,426
	Norwegian	45	3,166	,463
	Maths-Norwegian	30	2,950	,457
	Total	122	3,010	,460
Teacher readiness	Mathematics	47	3,263	,543
	Norwegian	45	3,355	,586
	Maths-Norwegian	30	3,460	,490
	Total	122	3,345	,548

Note. Scale, 1 = Strongly disagree; 2=disagree; 3=agree; and 4 = 'Strongly agree'; M, mean; SD, standard deviation.

Tab. 5: Factorial ANOVA of independent variables: Teacher beliefs and teacher readiness

		Sum of Squares	Df	Mean Square	F	Sig.
Teacher beliefs: the importance of computers	Between Groups	1,226	2	,613	3,369	,038
	Within Groups	21,646	119	,182		
	Total	22,872	121			
Teacher beliefs: supports learning	Between Groups	1,774	2	,887	4,420	,014
	Within Groups	23,878	119	,201		
	Total	25,652	121			
Teacher readiness	Between Groups	,711	2	,356	1,186	,309
	Within Groups	35,692	119	,300		
	Total	36,403	121			

The findings of teacher beliefs about the importance of ICTs and supports learning in Northern Norway are presented in Figure 3 and Figure 4, respectively. This shows that teacher beliefs in mathematics are significantly lower compared to Norwegian. Yet, this effect is reduced when looking at the teachers who teach multiple subjects.

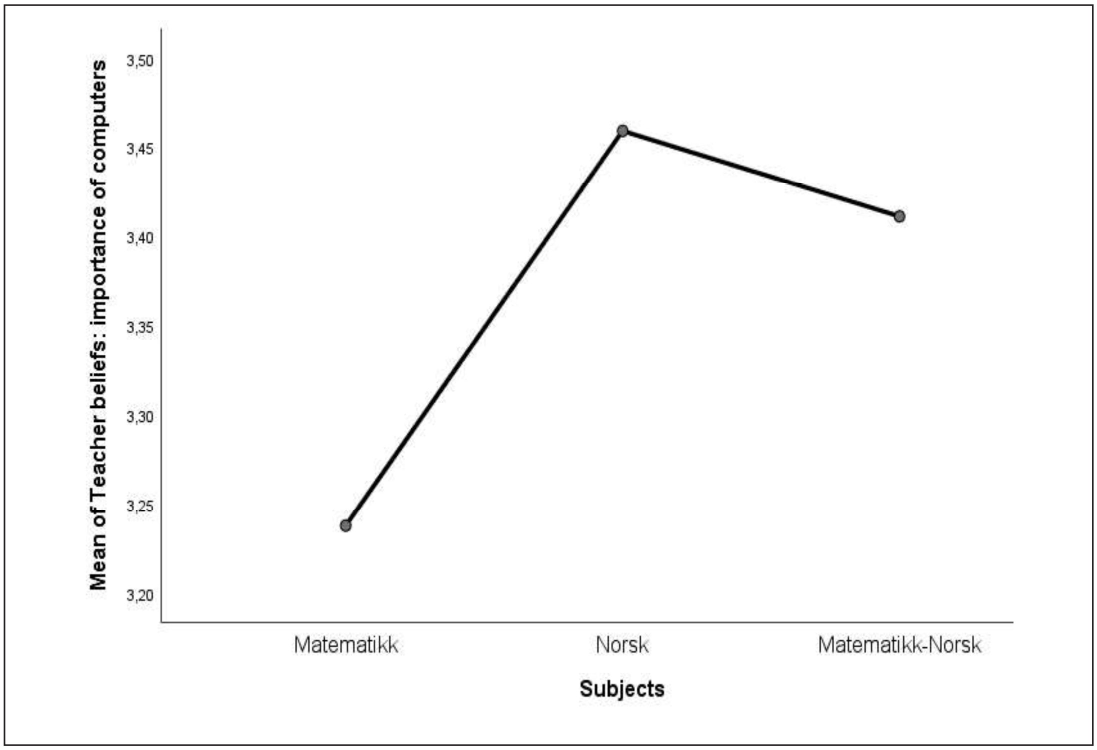

Fig. 3: Teacher Beliefs: The Importance of ICTs (Matematikk=Mathematics, Norsk=Norwegian)

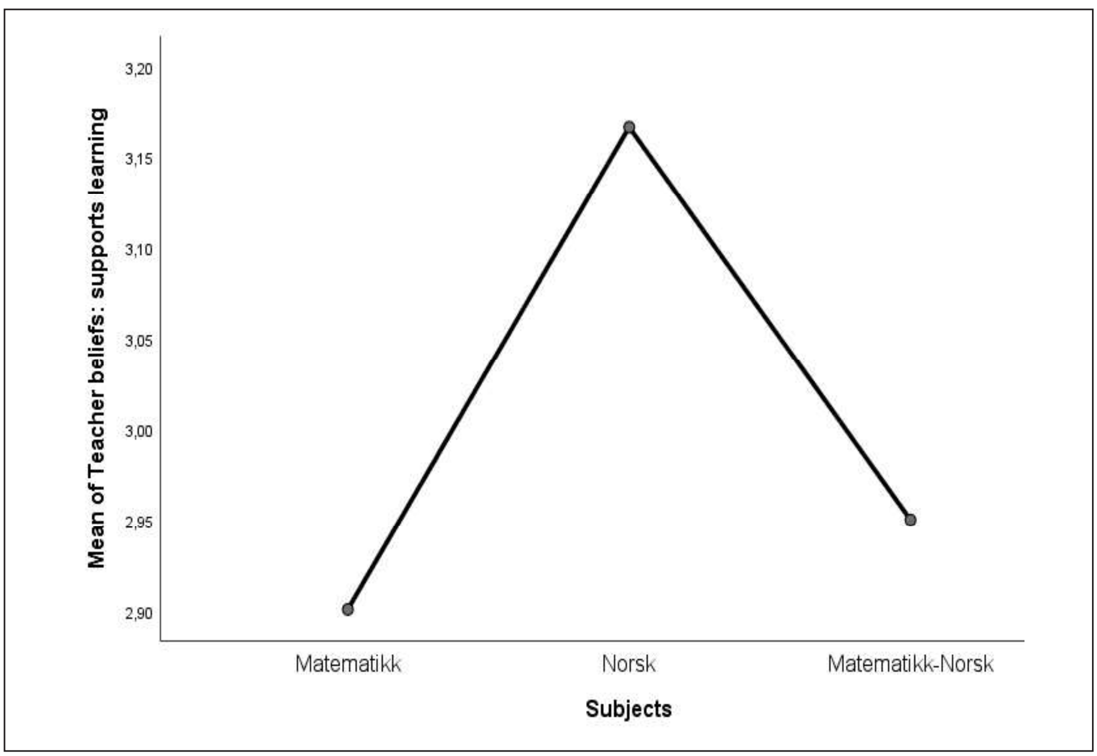

Fig. 4: Teacher beliefs: supports learning (Matematikk=Mathematics, Norsk=Norwegian)

Discussion and Conclusion

The relationship between subject area and technology integration is an under-researched area, and this chapter examined relationships between subject areas and known factors of technology integration: teacher readiness and teacher beliefs. These factors, which have been proven to have a direct impact on teachers' technology integration (Inan & Lowther, 2010), have been adopted by Howard et al. (2015) and form a part of a newly developed conceptual model (see Figure 1). This model investigates the relationship between the subject area and the other variables. This chapter tested the proposed model on a new dataset collected from schools in Northern Norway. The chapter analyzes the time spent in different subject areas and the relationship between subject areas with teachers' beliefs and readiness to use technology in education. The findings show that the subject area contributes to variations in teachers' beliefs and that the subject area is important for technology integration. At the same time, the results confirmed that these effects are reduced in a Norwegian school context, where teachers typically teach in several subjects. This situation, where the teachers teach in several subjects, is a special feature that characterizes Norwegian schools. This modified multiple-subject effect provides a basis for proposing a new conceptual model that would be suitable for analyzing the relationships between the variables in Norwegian schools.

The results confirmed that subject areas had a significant impact on ICT integration and a main effect on teachers' beliefs. Results showed no effect of subject area on teachers' readiness. However, this effect on integration and beliefs was reduced when compared with multiple-subject teachers' responses, indicating that the number of subjects reduces academic pretensions when teachers use ICTs in teaching and learning. Future research should test this proposed model (see Figure 5). Further, the modified multiple-subject effects will have an affinity to similar research on interdisciplinary and multidisciplinary approaches, where the specified knowledge base of the subject area seems to be blurred (Horlick-Jones, & Sime, 2004; Wheelahan, 2010).

However, the multiple-subject effects do not change the main pattern. The subject area does matter and can explain differences in teachers' beliefs and technology integration. The findings showed that mathematics teachers' use of technology is significantly lower compared to Norwegian teachers. At the same time, there is a significant relationship between the subject area and the teachers' beliefs, which indicates that the subject area is a crucial factor for technology integration. This result shows that the subject areas are not homogeneous, and technology integration is decisively shaped by the subject areas, giving rise to the different patterns expressed by teachers' different perceptions and use of technology in the classrooms. These differences between subject area and technology integration can be conceptualized as clashes and matches between technology practices and knowledge practices in various subjects (Howard, & Maton, 2011).

The present study is a contribution to the study of the importance of subject areas for technology integration in education. The conclusions presented in this study are

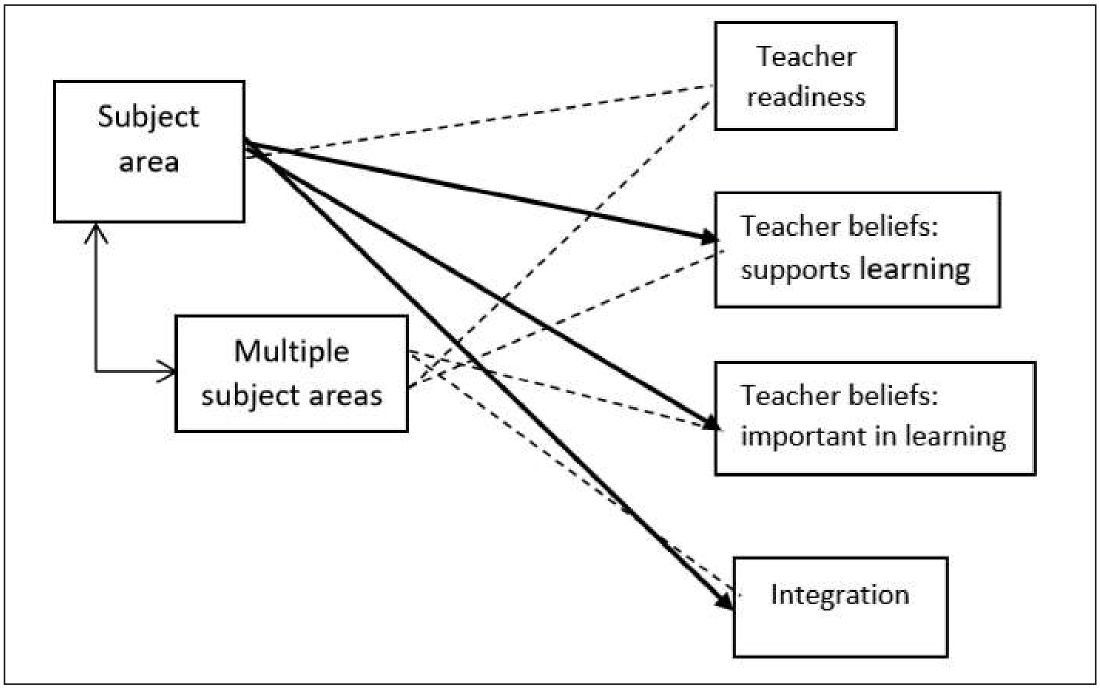

Fig. 5: Proposed Conceptual Model

preliminary, and further studies are required to fully understand the relationships between subject areas and technology integration. In Norwegian schools, teachers are obliged to teach a number of subjects, so there will be a particular need to study the modified multiple-subject effects on technology integration in education. In general, gaining a greater understanding of the connection between the subject area and technology integration will be of crucial importance for educational policy and curriculum. As the results suggest, technology integration in education cannot take place in a generic way but will depend on the subject area, forms of knowledge, and teachers' knowledge practices.

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