Enabling factors and self-efficacy: the case of Norwegian computer science teachers

Anna Mavroudi
Norwegian University of Science and Technology
Sem Sælandsvei 9, NO-7491 Trondheim
Norway
anna.mavroudi@ntnu.no

Monica Divitini
Norwegian University of Science and Technology
Sælandsvei 9, NO-7491 Trondheim
Norway
divitini@ntnu.no

ABSTRACT

Teacher self-efficacy can have an impact both on teaching practices and to student learning. The purpose of this case study was to gain a better understanding of the difficulties that computer science teachers face, focusing on resources allocation and other stakeholders' involvement in their activities. Thirty-two persons participated in this preliminary study. A questionnaire was disseminated to them which was inspired by the work of Bandura on teachers' self-efficacy. The modified version involved a 2x2 pattern: two main factors (influence school resources and enlist community involvement) measured across two aspects (self-efficacy and perceived importance). The results indicate high levels of self-efficacy and perceived importance for both aspects: school resources and community involvement. Furthermore, in some cases, the results indicate moderate to high associations. Also, the findings indicate same levels of self-efficacy on both genders and across different prior experience groups. The results can be interpreted through the prism of the Norwegian computing education context, but also in comparison with the literature and have the potential to inform educational policy and research on the topic at stake.

KEYWORDS

Teachers self-efficacy, community involvement in computing education, perceived importance of enabling factors

ACM Reference format:

A. Mavroudi and M. Divitini. 2017. Enabling factors and self-efficacy: the case of Norwegian computer science teachers. In Proceedings of the 6th Computer Science Education Research Conference, Helsinki, Finland, November 2017 (CSERC’ 2017), 6 pages.

1 INTRODUCTION

During the past years, the Norwegian government has responded to a call coming from diverse forces of the society to expand the computing education curriculum. Norway does not have a long tradition of computing education in schools compared to other countries like UK or Greece. In this changing era and while the computing education in secondary education is still relative new and dynamically evolving, it is important to gain a better understanding of the beliefs of computer science teachers in Norway in two things: 1) their capacity to influence or manage factors that affect their professional attitudes (or even performance) and 2) the relative importance of these factors. Especially the former is related to the concept of self-efficacy which, although it was initially introduced more than two decades ago by Bandura [1], it still continues to interest researchers, policymakers, and practitioners.

Self-efficacy has received particular attention in education, from the student and from the teacher viewpoints. Teachers' self-efficacy was examined with respect to various aspects and target groups. Especially with respect to gender and years of teaching experience, there have been concerns in the literature in conjunction with tutor self-efficacy; see for example, [17] and [18]. Also, frequently researchers examine computer self-efficacy of student or teachers. This paper has a different focus since it discusses self-efficacy of computer science teachers not with respect to their computer self-efficacy, but with respect to other aspects relevant the local context. Consequently, given its economic and educational context, this paper discusses the challenges faced by Norway's education system from the teachers’ perspectives. What makes the topic of the paper particularly interesting is that the Norwegian curriculum in computing education is not well -established yet, because computing-related courses were only recently introduced in the education system. Drawing from the literature and the Norwegian official policy documents ([13], [14]) the research questions seek to extend our knowledge with respect to computer science teachers:

- What are the levels of self-reported efficacy to influence school resources among computing educators and enlist community involvement?
- How important do they think that school resources and stakeholders’ involvement are?
- Are there associations among a) the self-efficacy types, and b) their perceived importance, as enabling factors?
- Are there differences with respect to gender?

The paper is organized as follows: the next section describes background knowledge focusing on teacher self-efficacy and the computing education context in Norway. Next, we describe the research method with respect to the participants’ profiles and the research instrument design. Following, we present the results of the statistical analysis and we discuss them in the light of the research questions. Finally, we conclude with implication of the
findings for research and policy or computing education, limitations and future work.

2 BACKGROUND

2.1 Teacher self-efficacy

Perceived self-efficacy refers to “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” ([1], p. 3). Among others, self-efficacy beliefs affect goal-setting and associated strategies, as well as the motivation to overcome barriers in order to reach the goals [3]. Teacher efficacy has been defined as “the extent to which the teacher believes he or she has the capacity to affect student performance” ([2], p. 137). Teacher self-efficacy predicts both teaching practices and student learning [14], has been related to student outcomes such as achievement [16] and has been shown to predict (among others) student motivation, achievement, students’ self-efficacy, attitudes, teachers’ goals and aspirations, as well as their attitudes toward innovation and change ([3], [14]). Self-efficacious teachers are more inclined to appreciate other school constituents’ involvement, as of example, the community colleagues, and staff, and to perceive the whole school as a system capable to fulfill its goals [4]. Finally, self-efficacy beliefs can play an important role in the gender differences that pertain to career-related behaviors and occupational goals, indicating that women narrowed their career choices partly due to lack of self-efficacy with respect to career-related behaviors, especially with respect to computing technology [11].

2.2 Computing education in secondary schools in Norway

In Norway, the curriculum in programming has been quite limited in the different stages of education. In lower secondary schools there was no curriculum on programming/coding up until recently. However, the Ministry of Education and Research recently proposed an elective course in programming that was piloted by a limited number of secondary schools in the country starting from fall of 2016 [6]. Due to large pressure, from the forthcoming school year (2017-2018) all schools have been authorized to integrate this elective subject in their curriculum, if they want. In upper secondary school, there are more options about specialisation in computing and programming, depending on the specific program that students choose.

In the recent years, a focal point has been the establishment of instruments for cooperation where the goal is realising STEM education as shared societal responsibility. In Norway the establishment of instruments that promote stakeholders’ cooperation is witnessed by synergies among:

- schools and municipalities, e.g. 45 municipalities in Norway got the status of STEM municipalities and financial support to establish networks to promote STEM education bringing together multiple actors;
- schools and university students, e.g. with the ENT3R program [9] to promote university students as role models in upper secondary schools, mainly with after-school activities.

The strategic document for the reform of STEM education [12] suggests and supports different forms of cooperation. For example, in the recommendations for the elective course on programming in lower secondary education, the Directorate for Education suggests that teachers should choose the activities and programming language based on their competencies, but also based on the competencies that are available in the local community, including universities and IT-companies that the teacher can cooperate with. On the other hand, Norwegian high school teachers report a high degree of self-efficacy and motivation to teach, but they declared that they receive less feedback and participate in fewer professional development activities than the European average [13].

3 METHOD

3.1 Participants and process

To meet our research objectives, we designed a questionnaire. It was distributed to approximately sixty participants all of them attending an experience-sharing conference for teachers that took place in Norway. The conference had a focus on computing education. The questionnaire was administered to the participants in a printed version and it was written in Norwegian. In total, thirty-two persons participated in this study by fully completing the questionnaire. Eleven of them were women and twenty-one were men, most of them being between 25 and 44 years old.

Figure 1 shows the distribution of the participants grouped by age and gender. In terms of professional experience, most of the participants had between 6 and 15 years. Figure 2 shows the distribution of the participants across gender and years of professional experience.

![Figure 1: Participants profile (age grouped by gender)](image)
A questionnaire was employed to study participants’ beliefs about the difficulties for computer science teachers in the school. In terms of demographic data, the first part of the questionnaire focused on: gender, years of teaching experience, and age. The second part of the questionnaire is a modified version of Bandura’s questionnaire on teacher self-efficacy scale ([1], [8]), focusing mostly on two dimensions relevant to the research questions at stake: influence school resources (corresponding to the “Efficacy to Influence School Resources” sub-scale in the original Bandura’s questionnaire) and enlist community involvement (corresponding to the “Efficacy to Enlist Community Involvement” sub-scale in the original Bandura’s questionnaire). These subscales are more relevant to the context of the computing school education in Norway and as such, they can help to examine relationships between school contexts and teacher self-efficacy [17]. Especially for the availability of teaching resources, and the quality of the school facilities, literature argues that these constitute elements that “teachers consider in their assessment of the difficulty of their tasks in determining how successful they expect to be at that task”([17], p.3). Also the focus on resources is particularly relevant because computing education might require more resources than other subjects, resources that are often getting outdated. In addition, innovative learning scenarios of IT often require the acquisition of equipment that is normally not available in the classroom. The research work was conducted in the context of a Horizon2020 European project, which focuses on such scenarios. The sub-scale on involvement of stakeholders is related to the Community of Practice perspective, which is important specifically to IT education: partnerships among university, industry and the schools can promote integrative learning which is relevant to the society needs.

For each of the questions originally included in the Bandura’s original questionnaire in these sub-scales, we included an additional question asking the respondents how important the specific factor is for him/her. All questions of the second part were expressed on a 9-point Likert scale. In the appendix, the interested reader can find the final questionnaire version. The reliability of the modified scale was high, as determined by a Cronbach’s alpha of .74. The statistical analyses of the data were performed by one of the authors using a dedicated statistical software while focusing on descriptive statistics measures and correlation analyses.

4 RESULTS

Table 1 presents descriptive statistics of the participants’ answers both with respect to self-efficacy and to perceived importance: minimum, maximum and average values (out of 9) and standard deviation of the answers. It can be inferred that all the scores are relatively high. Tables 2 and 3 present correlations among the scores of different dimensions of efficacy (use of resources and the four types of involvement), as well as, among their perceived importance, respectively. The values of Kendall’s tau-b test reveal the strength and the direction of associations among the variables. (It should be noted that, in the case of ordinal variables, the same coefficient value represents stronger correlations than in the case of continuous variables.)

Figures 3 and 4 depict diagrammatic representations of the dialectic relationships among the variables that constitute our model of teacher self-efficacy and perceived importance of enabling factors, respectively. It should be noted that correlations do not reveal causality, but merely describe a moderate to low tendency in the former case, and a strong tendency in the latter case, but only among the perceived importance of the stakeholders’ involvement (university, community groups and industry/businesses).

With respect to self-efficacy across genders, Table 4 presents some descriptive statistics (average, standard deviation, median, number of cases). The results reveal small differences; consequently, four independent samples Mann-Whitney U tests were performed as post-hoc tests to determine whether the differences between males and females were statistically significant or not (Table 4). Distributions of the four self-efficacy types for males and females were similar, as assessed by visual inspection. All four types of self-efficacy types scores were not statistically significantly different between males and females, using an exact sampling distribution for U [5] (as shown in Figure 5).
**Table 1:** Descriptive statistics on self-efficacy and perceived importance among participants

|                      | Min | Max | Mean  | Std. Dev. |
|----------------------|-----|-----|-------|-----------|
| Resources - efficacy | 2   | 9   | 6.16  | 1.72      |
| Resources - importance | 5   | 9   | 7.38  | 1.18      |
| Community involvement - efficacy | 3   | 8   | 5.75  | 1.44      |
| Community involvement - importance | 5   | 9   | 6.91  | 1.38      |
| Industry involvement - efficacy | 3   | 9   | 5.63  | 1.54      |
| Industry involvement - importance | -   | -   | -     | -         |
| University involvement - efficacy | 2   | 9   | 5.66  | 1.62      |
| University involvement - importance | 4   | 9   | 6.88  | 1.48      |

**Table 2 Ordinal correlations for self-efficacy types**

|       | R   | CI  | II  | UI  |
|-------|-----|-----|-----|-----|
| R     | CC  | .313* | .436** | .221 |
|      | Sig. | .030 | .002 | .118 |
| CI    | CC  | .100 | .423** | .289* |
|      | Sig. | .030 | .004 | .046 |
| II    | CC  | .436** | .423** | 1.000 |
|      | Sig. | .002 | .004 | .013 |
| UI    | CC  | .221 | .289* | .352* |
|      | Sig. | .118 | .046 | .013 |

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

(R=Resources, CI=Community Involvement, II=Industry Involvement, UI=University Involvement, CC= Correlation Coefficient)

![Figure 3: Correlations among the self-efficacy type](image)

![Figure 4: Correlations among the perceived importance of the enabling factors](image)
Table 4 Self-efficacy types across gender

| Gender | R   | CI  | II  | UI  |
|--------|-----|-----|-----|-----|
| female | Mean| 6.00| 5.73| 5.91| 5.91|
|        | St.dev | 1.48| 1.19| .94 | .83 |
| Median | 6.00| 6.00| 6.00| 6.00|
| N      | 11  | 11  | 11  | 11  |
| male   | Mean| 6.24| 5.76| 5.48| 5.52|
|        | St.dev | 1.87| 1.58| 1.78| 1.91|
| Median | 7.00| 7.00| 5.00| 5.00|
| N      | 21  | 21  | 21  | 21  |

(R=Resources, CI=Community Involvement, II=Industry Involvement, UI=University Involvement)

Figure 5 The results of the Mann-Whitney U test for differences between males and females

5 DISCUSSION

The research literature supports the proposition that teachers perceived abilities given specific tasks are powerful predictors of their behavior as professionals [7]. A previous study conducted by OECD [13] revealed that teachers in Norway have a high sense of self-efficacy towards their work. On the contrary, another study that included thirty-five Greek computer science teachers, revealed low levels of perceived self-efficacy [10]. Our findings confirm the OECD study in the computing education domain and with a specific focus: how much do the survey participants think that they can do with the existing resources (teaching materials and infrastructures). Also, how much self-efficacious they are with respect to the stakeholders’ involvement (community groups, industry and businesses, university and colleges). The results reveal high levels of self-efficacy in both aspects. In addition, participants think that both aspects are important for their work.

Furthermore, there are moderate positive correlations among the different types of self-efficacy, practically meaning that if a person has a certain level of self-efficacy in one of the aspects then there is some possibility that she will the same level of self-efficacy in other aspects as well, as figure 3 indicates. This correlation is actually strong among the perceived importance of the different types of involvement (community, industry, university), as figure 4 indicates. The latter case clearly portrays the profile of the teacher who appreciates any type of involvement that can empower him/her as a professional. This is in line with previous findings that suggest that “self-efficacious teachers are more inclined to appreciate other school constituents’ contribution to the functioning of the school” ([4], p. 475).

Although there are gender considerations on self-efficacy reported in the literature, in our case we did not ascertain any: in both sub-scales of self-efficacy (resources and involvement) we notice similar scores among males and females. This is encouraging, especially taking into account that computing school education in Norway is still nurturing and does not have a long tradition.

6 CONCLUSIONS

Our findings have implications particularly relevant for policy aiming to improve education and maintain an effective environment in this domain. With respect to self-efficacy beliefs both literature and policy documents often focus on profiling teachers or students (usually in conjunction with computer or ICT skills), not on computing education stakeholders. Yet, it is imperative to focus more on computing education teachers since there is an ongoing reform in this domain in Norway, but in many other countries as well. This reform is driven by a rapidly growing demand “for requiring rigorous computing education where previously there has not been such requirement [and] the question arises as to the anticipated effects of such a major policy change” ([15], p.6); in this case, adopting the teacher viewpoint, while focusing on self-efficacy and perceived importance of enabling factors during the computing education reform in Norway.

Future plans involve two larger studies: 1) at the national level, trying also to identify differences between cities and rural areas, and 2) trans-national studies. A limitation that pertains to this research is the relatively small number of participants, making the findings less generalizable especially since all participants attended a conference on innovative didactic cases of computing education. On the other hand, the findings can be relevant to contexts that share the same basic characteristics: service to community and appreciation in collective work, satisfactory public investments in school education, and computing as a social responsibility.

ACKNOWLEDGMENTS

This work is supported by the European Union’s Horizon2020 research and innovation programme under grant agreement No. 710583 for the UMI-Sci-Ed (Exploiting Ubiquitous Computing, Mobile Computing and the Internet of Things to promote Science Education) project.
A. APPENDIX

Questionnaire on self-efficacy and perceived importance of the enabling factors

This questionnaire builds on the teacher Self-Efficacy Scale proposed in [1].

Demographic data

Age range:
- 18 to 24 years
- 25 to 34 years
- 35 to 44 years
- 45 to 54 years
- more than 54 years

Gender identity:
- Female
- Male
- Prefer not to say/Other

Professional occupation (if you have more than one, please select or describe both your main occupation and your secondary occupation):
- Teacher
- Teacher trainer
- Other (please describe):

Professional experience:
- 0 - 5 years
- 6-15 years
- 16-25 years
- more than 25 years

Questions:

In a scale from 1 to 9 (where 1 = nothing, and 9 = a great deal) please answer

1. a) How much can you do to get the instructional materials and equipment you need? b) How important are instructional materials and equipment?

2. a) How much can you do to get community groups involved in working with the schools? b) How important is to get community groups involved in working with the schools?

3. a) How much can you do to get local colleges and universities involved in working with the schools? b) How important is to get local colleges and universities involved in working with the school?

4. a) How much can you do to get local colleges and universities involved in working with the school? b) How important is to get local colleges and universities involved in working with the school?