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EDUCATIONAL TECHNOLOGY STANDARDS IN PROFESSIONAL DEVELOPMENT OF MATHEMATICS TEACHERS: AN INTERNATIONAL STUDY

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Abstract. Designing and implementing technology-based professional development of mathematics teachers is the key to fundamental, wide-ranging educational reforms. This development should be based on some suitable educational technology standards. In order to understand the extent to which the integration of technology in day-to-day teaching/learning has taken place in terms of such standards, we need to search for critical variables influencing their attainment. By adopting the ISTE Technology Foundation Standards for Students, this study used a sample of 134 mathematics teachers from Finland, Serbia and Slovakia—three countries at considerably different levels of technological development—to examine the subjects' interest to achieve these standards in relation to their computer attitudes and the received professional support concerning the standards. For these students, who studied at institutions that did not offer any explicit instruction on the utilized or other ET standards, three important findings were obtained. First, the interest was higher than the support: while on average the interest was medium, the support was rather small. Second, both the interest and the support for the Finnish subjects were lower than that for the Serbian and Slovak subjects. Third, the interest was primarily influenced by computer attitude. Implications for professional development of mathematics teachers and further research are included.

ZDM Subject Classification: U 79; *AMS Subject Classification*: 00 A 35

Key words and phrases: Educational technology; Technology Foundation Standards.

Introduction

To have students adequately prepared for adult citizenship, computer-based technology is to be routinely used at schools and universities [6]. "With the emerging new technologies, the teaching profession is evolving from an emphasis on teacher-centred, lecture-based instruction to student centred, interactive learning environments. Designing and implementing successful ICT-enabled teacher education programmes is the key to fundamental, wide-ranging educational reforms." ([8], p. 3) Such programmes should be based on some suitable educational technology standards, like those developed by *International Society for Technology in Education* (`www.iste.org`). The current edition of the ISTE National Educational Technology Standards for Teachers comprising 23 indicators[1] requires the following:

Contribution to ICMI Study 15 "The Professional Education and Development of Teachers of Mathematics", Sao Paulo-Brazil, 15–21 May 2005 (available at `http://stwww.weizmann.ac.il/G-math/ICMI/log_in.html`).

[1]see `http://cnets.iste.org/teachers/t_stands.html`

> "All candidates seeking certification or endorsements in teacher preparation should meet these educational technology standards. It is the responsibility of faculty across the university and at cooperating schools to provide opportunities for teacher candidates to meet these standards."

This important issue of preparing teachers has not been recognized by the ICMI Study 15 "The Professional Education and Development of Teachers of Mathematics", whose Discussion Document[2], to the authors' surprise, doesn't even use words "computer" and "technology". We agree that it is important to continuously examine the integration of technology in day-to-day teaching/learning [1], but to understand the extent to which this integration has taken place we need to search for critical variables influencing it. To examine this issue and undertake such a search, we adopted the ISTE Technology Foundation Standards for Students[3] (hereafter called 'the standards') and made a survey study for mathematics teacher candidates (hereafter called 'teachers') in Finland, Serbia and Slovakia[4]. Having in mind the cited request, as well as the undisputable facts that good teachers develop from those who are first and foremost good learners, and that computer attitude influences not only the acceptance of computers, but also their use as professional tools or teaching/learning assistants (see [9]), this study examined the following questions:

- To what extent are teachers interested in achieving the standards for themselves?
- Do teachers obtain an adequate professional support for reaching the standards?
- Are teachers' interests to achieve the standards related to their computer attitudes and the received professional development support concerning these standards?

Method

Subjects

This study used a sample of 134 mathematics teachers from Finland, Serbia and Slovakia (attending pre-service study programs or freshly graduated). The Finnish sub-sample comprised 68 students who had just completed their studies to become mathematics teachers (i.e. who completed subject studies in their mathematical faculties and pedagogical studies in their pedagogical faculties). The subjects came from six different institutions in different parts of Finland. The Serbian sub-sample comprised 31 fourth-year teacher candidates finishing one of the mathematical faculties in Serbia. The Slovak sub-sample comprised 35 students of those five-year teacher candidates, all of them in the second half of their study periods.

[2]see `www-personal.umich.edu/~dball/ICMI15study_discussion.doc.pdf`

[3]see `http://cnets.iste.org/currstands/cstands-netss.html`

[4]These countries may be good representatives for highly, average and poorly technologically-developed countries. According to the CIA World Factbook, a 2003 estimated GDP per capita for Finland is $ 27,000, for Slovakia $ 13,300, and for Serbia and Montenegro just $2 300 (see `www.cia.gov/cia/publications/factbook/`).

Design

The study primarily utilized factorial and correlative designs. The variables were Computer attitude, interest in personal achievement of the standards (Interest), and professional development supporting the standards (Support).

Instruments

The three variables were measured by Likert type surveys, whose profiles are given in Table 1. The English version of the applied instruments can be found at `www.joensuu.fi/lenni/survey/ICTSurveyOld.html`. Since we used a computer rather than technology attitude scale, we slightly changed the formulation of the original standards and their indicators by replacing the word "technology" by the word "computer".

Table 1. Profile of the applied instruments

Variable	Instrument	Alpha reliability			
		FIN	SER	SLO	ALL
Computer attitude	Selwyn's 5-point scale from strongly disagree to strongly agree [7]	.91	.89	.84	.87
Interest	4-point scale: none – small – medium – large	.79	.88	.73	.85
Support	4-point scale: none – small – medium – large	.82	.86	.75	.86

Procedure

The subjects were told the purpose of the study (examining their attitudes regarding computers and the standards) and they were asked to provide the requested data as accurately as possible. The subjects willingly provided these data. In Serbia the Selwyn's scale and the surveys were administered during regular students' activities (final lessons and exam at the end of the 2003/2004 academic year) by a teaching assistant from another institution. In Finland and Slovakia subjects submitted their answers by using a web-based questionnaire written in their mother tongues.

Results

Means and standard deviations of the measured variables for the three sub-samples and the whole sample are reported in Table 2. While the one-way analysis of variance revealed an insignificant F-value for computer attitude ($F_{2,131} = .12$, $p = .89$), significant such values were obtained for both Interest and Support (Interest: $F_{2,131} = 21.38$, $p < .01$; Support: $F_{2,131} = 27.74$, $p < .01$). For these two ET standards' variables, we applied the multiple comparison test with Bonferroni correction for a .05 significance level and found that their means for the Finnish sub-sample were lower than those for the other sub-samples. The t-test for paired samples revealed that the mean of Interest was higher than that of Support in each of the three sub-samples (FIN: $t = 12.46$, $df = 67$, $p < .01$; SER: $t = 4.49$, $df = 30$, $p < .01$; SLO: $t = 9.31$, $df = 34$, $p < .01$) as well as in the whole sample ($t = 15.20$, $df = 133$, $p < .01$).

Table 2. Means and standard deviations of the measured variables for the three sub-samples and the whole sample

country	**Computer attitude** M(SD)	**Interest** M(SD)	**Support** M(SD)
FIN	84.41 (11.41)	1.84 (.54)	.84 (.54)
SER	84.39 (11.47)	2.24 (.67)	1.64 (.69)
SLO	85.51 (12.37)	2.56 (.40)	1.53 (.52)
ALL	84.69 (11.60)	2.11 (.62)	1.20 (.68)

Correlations among the measured variables for the three sub-samples and the whole sample are reported in Tables 3–6. The correlation between Interest and Computer attitude was significant as well in each of the three sub-samples as in the whole sample. Except for the Slovak sub-sample, significant correlations between Interest and Support were found in the other analysed cases. [Partial correlations among the measured variables controlled for country were .54 (variables 1 and 2), .26 (variables 2 and 3) and .07 (variables 1 and 3), the first two of which were significant at a .01 level.] In each of the four analysed cases, the multiple stepwise type (pin = .05) regression analysis with Interest as independent variable and Computer attitude and Support as dependent variables revealed that Interest is primarily influenced by Computer attitude. While in the Finnish sub-sample both Computer attitude and Support remained in the equation respectively accounting for 25% and 8% (33% in total) of the variance of Interest ($F_{2,65} = 16.16$, $p < .01$), in the Serbian and Slovak sub-samples only Computer attitude remained in the equation respectively accounting for 43% ($F_{1,29} = 22.15$, $p < .01$) and 31% ($F_{1,33} = 14.54$, $p < .01$) of this variance. [In the whole sample, country, Computer attitude and Support respectively accounted for 24%, 23% and 3% (50% in total) of the variance of Interest ($F_{3,130} = 44.15$, $p < .01$).]

Table 3. Correlations among the measured variables for the Finnish sub-sample

Variables	2	3
1. Computer attitude	$.50^{**}$	$-.06$
2. Interest		$.26^{*}$
3. Support		

$^{*}p < .05$ $^{**}p < .01$

Table 4. Correlations among the measured variables for the Serbian sub-sample

Variables	2	3
1. Computer attitude	$.66^{**}$	.29
2. Interest		$.40^{*}$
3. Support		

$^{*}p < .05$ $^{**}p < .01$

Table 5. Correlations among the measured variables for the Slovak sub-sample

Variables	2	3
1. Computer attitude	.55**	.12
2. Interest		.02
3. Support		

**$p < .01$

Table 6. Correlations among the measured variables for the whole sample

Variables	2	3
1. Computer attitude	.49**	.08
2. Interest		.43**
3. Support		

**$p < .01$

Discussion

Three important findings emerged from this study. First, Interest was higher than Support: while on average Interest was medium, Support was rather small. Second, both Interest and Support for the Finnish subjects were lower than that for the Serbian and Slovak subjects. Third, Interest was primarily influenced by Computer attitude.

Although no explicit instruction on the utilized or other ET standards has been provided at any of the institutions involved in this study, the subjects' Interest was higher than Support they had received in each of the three countries. Such a finding was expected because the students' sensitivity to the personal and societal needs of learning seems to be higher than that of their educational institutions. On the other hand, in a technologically highly developed society such as Finland, many of the basic routines concerning ICT not only appear quite natural for the subjects but have also been integrated as a part of their educational processes. Nowadays in Finland many students have personal websites including several kinds of media, for example. It is appropriate to note that a process for producing (especially an adequate) hypertext combines four important components connected to any kind of learning: planning, transformation, evaluation, and revision (see [5], for example). In his dissertation Eskelinen showed that even a short period of time of working within socio-constructivist collaborative ICT-based design processes to produce a hypermedia-based learning environment not only changed Finnish students' conceptions of teaching and learning (from objectivist-behaviorist view to constructivist view) but also decreased their interest to have support for computer routines [3]. These kinds of facts might explain why both Interest and Support for the Finnish subjects were lower than that for the Serbian and Slovak subjects.

Although for the Finish, Serbian and all subjects, Interest was related to both Support and Computer attitude, Interest was primarily influenced by Computer attitude, which is in accord with Kadijevich who recognizes, though theoretically, computer attitude as an important critical issue of applying educational technology standards to professional development of mathematics teachers [4]. As the result of the applied multiple regression analysis for the whole sample evidenced, the influence of Support on Interest was still significant though of a small size (just 3%).

To summarize: this study, which to our knowledge is probably among the first such studies on the topic, revealed that Interest was higher than Support and that Interest was primarily influenced by Computer attitude, clarifying a direction for professional development of mathematics teachers concerning ET standards. Further research may elaborate on the issues raised by this study by using larger samples from more countries and comparing the findings for primary and secondary teacher candidates and across subject areas. As an appropriate treatment can help pre-service mathematics teachers develop a strong positive relationship with technology (see [2]), further research may primarily deal with the design and utilization of learning experiences for mathematics teacher candidates promoting a better Support, a higher Interest and more positive Computer attitude, which, in turn, would result in a wider and more adequate integration of technology in day-to-day teaching/learning of mathematics—a must of our information age.

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