Zsuzsa Buzás – Tamás Csontos – Ágnes Maródi

Testing Teacher Candidates' Knowledge Elements of Research Methodology in an Online Test Environment

Summary

It is necessary to prepare future teachers to be able to access, interpret and use research results, and publish of their research work. The acquisition of research methodological material and knowledge are therefore essential for teacher candidates. In Hungary, there have been only few studies on research skills and knowledge, and we have little testing experience in this area. The development of research skills of students typically starts late and stops in secondary school, all of which can have an impact on higher education and teacher training. Our research goal was to examine the research methodological knowledge of primary school teacher candidates and kindergarten teacher candidates using an online test that examines the most important knowledge elements of the research methodology with its various tasks. We examined whether there is a difference in the levels of research knowledge test performance between primary school teacher and kindergarten teacher candidates.

Keywords: research knowledge, tertiary education, online test

Dr. Zsuzsa Buzás PhD, college senior lecturer, Károli Gáspár University of the Reformed Church in Hungary (csontosne.buzas.zsuzsa@kre.hu); Dr. Tamás Csontos, college senior lecturer, Károli Gáspár University of the Reformed Church in Hungary (csontos.tamas@kre.hu); Ágnes Maródi, PhD student, SZTE Doctoral School of Education (agimarodi@gmail.com).

Introduction

The theoretical framework for research-based teacher education has been developed by Finnish researchers and has become one of the features of the general school systems nowadays. Its effectiveness can be measured by online testing of associated skills and knowledge in higher education among students at regular intervals. Acquisition of research methodological knowledge is essential for teacher candidates. It helps them, among others, in the critical analysis of the pedagogical literature and in their practical pedagogical work resulting in measurements and analyses, in research planning as well as in the implementation and evaluation of their activities and publishing the results. During their studies future teachers become familiar with digital technologies of research practice, and the integration of ICT tools in education. Korom and her colleagues (2016) study the most important elements of scientific inquiry skills online among high school students. According to their results, there is no change in inquiry skill development in Hungarian secondary education. Based on their research those students who study science subjects at an advanced level performed significantly better (70.4%) than those who study science subjects at an intermediate level (60.5%). Korom, B. Németh and Pásztor (2013) also carried out online research into the development of inquiry skills in a 20-item online test. According to their research, in the 6th grade the test does not measure reliably, and the reliability indicator also indicates problems in grade 6 (Cronbach-α = 0.67). This the reason for this may be that the upper age group is not yet familiar with concepts such as a *research question* or *hypothesis*. Thus, based on this research, the development of research skills starts late and stops in secondary education; all has an impact on higher education and teacher training.

Research-Based Teacher Training

The COVID-19 pandemic led to major education policy changes around the world in 2020. Around one and a half billion students in 194 countries – 90 per cent of the students in the whole world – are currently benefiting from digital distance learning outside the classroom, typically at home, since March 2020. Within a short time, new teaching methods and technological tools have been integrated into traditional school learning and new types of educational coalitions have emerged as a result of international cooperation (Holle, 2020). The concept of research-based teacher education is to prepare teachers themselves to directly access, interpret and use research results and to carry out research work, as well. According to this teacher training model, teachers can be both creators and immediate users of new scientific results, thus significantly accelerating innovation and shortening the process from the creation to the use of research results (Csapó, 2015). Candidate teachers need to be trained to monitor where good practice is emerging, where new scientific findings on teaching can be found, or how computer-assisted teaching methods and tools can be used to make teaching more effective. They should have information on where and how they can become involved in research and development programmes, the results of which can be used in their teaching. Research-based teacher education is developing a new role model, i.e. the research-innovating teacher.

Teachers are continuously developing themselves throughout their lives and are able to implement the latest research findings in their everyday teaching practice. Research-based teacher education is most consistently implemented in the Finnish education system, which is considered one of the best in the world (Csapó, 2015). Finland's education system is a model to be followed by professionals of many nations. Today, Finland is one of the most educated nations in the world, with a third of the population having a university degree or an equivalent. All subjects are taught by teachers in grades one to six. Finnish pupils are usually ranked between 1st and 7th in the OECD countries in the PISA tests in reading, mathematics and science. Finnish teacher education integrates the role models of researcher and teacher, thus promoting continuous innovation in education (Kárpáti, 2008).

Teaching is a very popular career option in Finland. Due to its popularity, some teacher training courses can be over-subscribed by a factor of fifteen to twenty, and over-subscription for special teacher training has been more than thirty times in recent years (Bús, 2015). According to national statistics, in 2017, nearly 1100 students passed the entrance test for the Helsinki teacher training programme, of whom 121 (11.3%) were accepted to start their studies. According to the university's website, the Jyväskylä teacher training programme had 2,389 applicants in 2014, of which only 80 (3.3%) were accepted; a year later, only 90 (5.9%) were accepted out of the 1,525 applicants. This means that only a fraction of applicants are admitted to teacher training (Szabó, 2018).

A large immersion base allows selecting the most suitable students. The admission procedure is very complex; in addition to the marks obtained, candidates must pass a written test based on pre-set and independently researched literature. A Master's degree is required for different BA teaching courses. Educational science is central to the curricula of the BA and MA training. The subjects of educational science account for roughly half of the teacher training, apart from other elective, language and communication courses. A specific course deals with the effective application of ICT tools in teaching. Finnish future teachers are trained to read and interpret scientific publications. In the master's programme, they are expected to carry out five to seven weeks of independent quantitative or qualitative research (Bús, 2015).

Research Skills And Knowledge

The methodological issues of pedagogical research in teacher education cover a wide range of topics, from general methodological knowledge to the presentation of specific research strategies, methods, tools, data collection and processing procedures. In Hungary a one-semester research methodology course is usually offered to students of pre-school and teacher education in the second academic year, usually in the autumn semester. The volume *Introduction to Methods of Pedagogical Research* edited by Iván Falus in 1996 is compulsory reading. The knowledge to be acquired typically covers the aim, subject and characteristics of pedagogical research, the design of pedagogical research (definition of the research problem, techniques for exploring and processing the related literature, the rules of reference, hypothesis, sampling, designing the data collection method, designing the data analysis, and publishing the results) and the knowledge related to writing the research design. Other topics include

the implementation of the research design: characteristics of a good hypothesis, methods of pedagogical research (field research, historical research/documentary analysis, questionnaires, testing, qualitative and quantitative research), sampling, analysis and data processing, as well as the publication of research results, and publication (abstract, formal requirements, general requirements). Other topics related to the course include the development and development opportunities of digital competence, the role of ICT tools in education in the areas of skills development, learning and assessment and measurement. The course also focuses on the preparation of the thesis, the selection and discussion of the research topic. The research methodology course relies to a certain extent on the specific elements of prior scientific thinking, research skills and knowledge related to scientific investigations, which are also key elements in the standards of science education and play a central role in international studies. By upper secondary school, students should already have a good understanding of how science works, the nature of scientific research and the basic skills needed to formulate research questions and hypotheses, design investigations, represent data, analyse and interpret data, and draw conclusions. Research skills are not measured in isolation but embedded in the content areas (biology, physics, chemistry and geography) (Csapó, 2015). There is a wealth of experience on how to evaluate the effectiveness of research-based learning. Typically, the use of scales that describe scientific thinking in terms of three activities (formulating hypotheses, designing and carrying out investigations, and interpreting research results) has been proposed. Using technology-based diagnostic tests that can be easily integrated into everyday pedagogical practice, Korom (2015) investigates the development of primary and secondary school students' scientific thinking and inquiry skills. To the best of our knowledge, inquiry skills assessment in higher education is being implemented for the first time in teacher education through an online platform.

Online Testing and Evaluation

In the 21st century, digital literacy is an essential set of skills that includes the use of digital tools, digital literacy and active participation on the internet. Digital presence refers to the ability to use digital tools and online applications to a degree that ensures that individuals are both valuable and useful to society. Digital content acquisition is an essential competence for teachers and students in school life, as it can facilitate, support and motivate them to acquire different types of knowledge.

Digitalisation is constantly shaping the demands on education systems and the methods of learning and teaching. In the current pandemic situation, the face-to-face interactions between teachers and students have almost disappeared, and it has become clear that teaching and learning activities without digital tools can no longer be effective in the long term.

According to digital pedagogy as a new approach to teaching, the teacher's task is not to teach information, but to teach students how to find their own answers and solve problems. Another important aspect is the division of labour - and the development of social skills in this process - because finding, evaluating and applying information is more effective when done in parallel and from multiple perspectives.

The success of the digitalisation of education depends largely on applying the right digital skills. According to an OECD analysis based on international surveys, teachers have above-average ICT and problem-solving skills, but they score lower than other tertiary educated groups. Teachers believe that it would be useful to develop their digital competences. However, it is not enough to train teachers in the use of ICT tools, but rather to emphasise a changed pedagogical approach (Ollé et al., 2014).

Digital tools are creating new opportunities not only in the learning and teaching process, but also in assessment and evaluation. The attitudes and expectations of the new generations are very different from those of previous generations, and their use depends on the technology habits of students, the digital competences of teachers, task writers and data analysts (Holle, 2018). Countries that have adopted digital tools in education are at the top of the OECD PISA international education results (e.g. Finland and Korea) or among the countries that have made significant progress (Malaysia and Kazakhstan). Online assessment has several advantages, e.g. it is anonymous, fast, motivating for learners, easy to use, interactive, and environmentally friendly. It allows images to be uploaded and large sample sizes to be tested, even abroad. Several online platforms are available, with an interface that can provide a fast, valid, reliable testing method and effective support for both teachers and education professionals. Compared to paper-based tests, online test systems offer a wider range of response options. For example, clicking on images, parts of images, texts, parts of texts, numbering based on the order of clicking, letters, words, sentences, texts, numbers, shapes, images, sounds, videos, and tasks that require moving virtually any task item to a given target area, input boxes and text boxes that require typing letters, numbers, and words (Molnár, 2018).

Testing The Elements Of Research Knowledge

Studies have typically targeted upper primary and secondary school age groups, where students' inquiry skills have been explored. To our knowledge, this is the first survey of inquiry skills of future kindergarten and primary school teachers. We aimed to test their knowledge using technology-based methods, tools and procedures. In our research, we sought to answer the question whether their research knowledge can be measured with tasks on an online platform, whether the test and its subtests are reliable. We investigated whether there is a difference in the test performance levels between future kindergarten teachers and primary school teachers.

Sample

The sample consisted the students of a teacher training faculty in a county seat (N=59; the proportion of men is negligible) (Table 1).

At the teacher training faculty, students study research methodology for one semester, 45 minutes per week. The sample includes second-year students. Future kindergarten teachers are due to complete their thesis in the next academic year, while future primary school teachers are due to complete their thesis in two years. Their research methodology course helps them, among others, to choose a thesis topic.

Table 1: Sample characteristics

Training profile	N	Female (%)	Male (%)
Kindergarten teacher	33	100	0
Primary school teacher	26	92.2	7.8
Total	59	96.6	3.4

Source: own construction

Testing device

The online test consisted of 35 closed questions in three sub-tests: (1) research design questions: identifying the research question, designing their research (2) conducting the research, using different research methods and (3) publishing the research results.

For future teachers it is essential to be familiar with online test editing platforms (e.g. eDia; Electronic Diagnostic Measurement System, or Google Forms). Online platforms are usually suitable for computer-based testing. In order to use them, it is necessary to know the basic concepts, for example the concept of the test itself and its parts (subtest/subtest, task/item). The teacher candidates had to choose the appropriate methods and tools for their thesis research and be familiar with their characteristics.

Figure 1: Example of a task related to the types of research

Source: own construction

In pedagogical research, teacher candidates must be familiar with the related literature, as literature review plays a crucial role in their studies. The aim of the literature review, the most important aspects of research, and the conditions for publication were included in the third subtest (Figure 2).

Figure 2: An example of a task related to literature review

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15. What are the secondary literature sources?
Click on the correct answer!                              1 mark

o        journals
o        books
o        dissertations
o        textbooks and notes
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Source: own construction

Data retrieval

The research was conducted in autumn 2020. Due to the pamdemic situation, the second-year teacher candidates completed the test in their homes. The data was collected with Google Forms and analysed using SPSS 17.0 software.

Results

The reliability of the overall test (Cronbach's alpha = 0.811) is good, so the test is suitable for testing students' research knowledge (Table 2). The Cronbach's alpha is lower for the three subtests. The test reliability for kindergarten teacher candidates is Cronbach's alpha=0.701, while the test reliability for primary school teacher candidates is Cronbach's alpha=0.691. This may be due to the small number of tasks and the small number of participants in the pilot study. Both numbers can be increased in the future.

Table 2: Test reliability

Subtests	Number of the items	Cronbach-alfa
Theoretical background	13	0.581
Carrying out research	15	0.546
Publication	7	0.281
Whole test	35	0.811

Source: own construction

Internal correlation of the test and subtests

The correlation analysis shows that the performances on the test and the subtests are moderately and strongly correlated, i.e. the measured knowledge structure is homogeneous (Table 3). The strongest correlation was found between the whole test and the subtest related to publishing (r=0.86, p< 0.001). The correlation was also strong between the whole test and the subtest on the theoretical background (r=0.83, p<0.001) with a moderately strong correlation between the whole test and the subtest on the implementation of the research (0.57, p<0.001).

Table 3: Intercorrelation of the subtests

Variations	Full test	Theoretical background	Research
Theoretical background	0.83**		
Research	0.57**	0.30*	
Publication	0.86**	0.51**	0.36**

Source: own construction

The analysis of the students' performance

The average performance of the teacher candidates in the research methodology test was 84%, with a corresponding standard deviation of 8.52. The highest numbers of correct answers were given for the questions on the theoretical background, the characteristics and specificities of research - with more than 80% of them answering the questions correctly. This was followed by the results of the subtests on knowledge related to theoretical background, publication and the implementation of pedagogical research, with a high proportion of correct answers. The performance of the future primary school teachers was significantly better than that of the future kindergarten teachers in both the whole test (t=2.576, p=0.13) and the test related to the implementation of the research (t=2.924, p=0.05). The results are summarised in Table 4.

Table 4: Test achievement by field of study (%)

Subtests	Kindergarten teachers		Primary school teachers	
	Average (%)	SD (%)	Average (%)	SD (%)
Theoretical background	79.48	16.05	84.02	11.9
Research	75.35	12.52	84.36	10.65
Publication	77.05	16.72	83.51	8.75
Whole test	77.22	11.21	84.06	8.52

Source: own construction

Task 3, i.e. the question on the characteristics of different digital technology tools, was the most difficult for the students. Only 40% of them were able to solve the task. Students also found it difficult to identify a particular research method (around 40%). The questions on the process of pedagogical research and the research topic (task 1 and 5, respectively) proved to be the easiest, as everyone answered them correctly.

Future teacher students' performance was significantly higher on the question about subject pedagogic knowledge (task 3) (t=2.601, p=0.012), and the mean of the kindergarten students was significantly higher on task 13 related to the research problem (t=2.092, p=0.041).

The performance of future primary school teachers on the subtest tasks related to the implementation of the pedagogical research was significantly higher than that of the kindergarten teacher candidates on several tasks. The question on semi-structured interviews (task 18) was answered correctly by more than 80% of primary school student candidates and only half of the future kindergarten teachers (t=2.403, p=0.020). While all future primary school teachers gave the correct answer to the question on qualitative research instruments, only one third of the future kindergarten teachers did so (t=2.738, p=0.008). Also, the mean scores of the primary school teacher candidates were significantly higher for the question on sampling (task 34) (t=2.192, p=0.032) and the question on questionnaires (task 18) (t=2.403, p=0.020). The most difficult items were task 31 (39%), 30 (54%) and 28 (58%); all of them are related to digital technology tools.

In the section on interpreting research results, the performance of the future primary school teachers was significantly higher on referencing (task 35) (t=2.619, p=0.011). A high number of students solved correctly the task on online pedagogical journals and abstract formatting requirements (task 12 and 32, respectively), but less than half of the students gave a correct answer to the question on secondary literature sources.

Summary

Due to the global pandemic, the 2020 school year brought a number of unforeseen changes and unexpected events that changed the teaching-learning process and its methodology in many ways. As teaching and assessment is now online, digital assessment and evaluation is playing an increasingly important role in improving the quality of feedback. The aim of our study was to investigate some of the characteristics and related basic concepts of research knowledge among future kindergarten and primary school teachers. We conducted our research using a technology-based online assessment tool that was suitable for recording and processing data and easy to navigate. The reliability of the test for primary school teacher candidates was found to be good (Cronbach's α=0.811). The average performance of the students on the test was 84%, with a corresponding standard deviation of 8.52. The results of the pilot study indicate that the knowledge of future primary school students is significantly higher than that of the other group. One of the reasons for this may be that kindergarten teacher candidates do not study subject pedagogy and that there is more time available for future primary school teachers to deepen their knowledge. As far as the subtests are concerned, the scores for the question on the implementation of the research were also signifi-

cantly higher for primary school teachers. This may be due to the higher scores required to enter the degree programme, and perhaps their science skills are also better than those of their kindergarten teachers. However, this has not yet been investigated. There were only two male students in the sample, which may indicate a low level of appreciation of the teaching profession.

Our online assessment tool, used in the Research Methodology course, can help to assess students quickly and accurately. The results can be used to redesign teaching-learning strategies, plan and implement educational goals and activities. In addition to completing the online test, the students had to submit a research plan related to their theses. The most popular topics among kindergarten teachers were movement development (e.g. swimming, water habituation, coordination ladder or other movement therapies), speech development, opportunities for dramatic interactive storytelling, early foreign language acquisition, the use of digital tools by preschool children and the exploration of their musical abilities.

Future primary school teachers selected a wide range of topics as well, e.g. the use of digital tools, spelling, foreign language teaching or internet addiction. Other topics included literacy research, motivation, school bullying, education of Roma children, music education, emotional intelligence, health education and physical education, forest school, and zoo pedagogy. Theses in the field of vocal music cover a wide range of research areas; for example, the study of different musical skills, testing skills, the use of digital tools in music education, the role of choirs and orchestras in music education, eye-tracking and online studies in the field of music reading, the study of the transfer effects of music, studies related to specific instruments, the role of motivation, creativity, the relationship between music and movement, the role of music in language teaching and reading, the relationship between music and mathematics and visual fields, listening to music in school, film score, the study of specific methods (Kokas pedagogy, the Kodály concept, László Sáry's creative musical exercises), comparative studies of textbooks and teaching materials, the role of folk traditions, and etc.

Our research investigated the research methodology skills of teacher candidates. Measuring and testing BA students' inquiry skills online can open up further research opportunities, which can serve as a basis for developing programmes to develop their skills and knowledge, as well as their motivation. With a valid and reliable assessment tool, students will not only enhance their scientific inquiry skills and research methodological knowledge, but will also come closer to one of the fundamental goals of the 21st century teacher education: to become innovative researchers, as well.

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