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Evidence-based practices in teaching

Summary

This article presents the results of the implementation of the Erasmus Plus project (KA203 financed by the European Union, contract number 2019-1-NL01-KA203-060339) Research in Teacher Education (RiTE). The aim of the project was to promote and facilitate pre-service teachers to create and undertake evidence-based practices in teaching science, technology, engineering, and mathematics (STEM). In the RiTE project, pre-service teachers were encouraged to use evidence from educational and scientific research and to experiment and introduce didactic innovations in teaching and learning processes. Although it has its justification in the tradition of thinking about science, evidence-based practice is not yet consciously applied in school practice. In the article, we present both the theoretical framework for such practices, and the results of qualitative research – an analysis of interviews conducted with students, future teachers, and novice teachers involved in the project. The presented results show changes in the context of an understanding of evidence and what evidence-based practices are in the teaching process and the vision of such teaching presented by the respondents.

Keywords: evidence-based education, teacher training, action research

Słowa kluczowe: edukacja oparta na dowodach, kształcenie przyszłych nauczycieli, badania w działaniu

Introduction

The teaching process is a complex system in which particular components interact with each other and influence the final presence and functioning of the entire system. The functioning of such systems is by nature difficult to study and to model due to the correlations, competition or other types of interactions between elements of the system and between such elements and surroundings. Lemke and Sabelli noticed that "the education system is one of the most complex and demanding research systems" (2008: 128). Tasks faced by a teacher are immense and difficult, especially in a dynamically changing society. A teacher is not only a director of events (Wiśniewska-Kin, Rybska 2020) and an architect of students' knowledge (Dylak 2013), but also an educator, a person of passion (Day 2005), a mentor and tutor (Welskop 2013), an advisor, organiser, "translator" of the reality and consequences of choices made by students (Siemak-Tylikowska, Kwiatkowska, Kwiatkowski 1998) or researchers (Borek 2012; Kołodziejski 2014).

Adepts of this profession starting their professional career face challenges related not only to professional adaptation or career path, but also struggle with the dynamics of students' groups in various forms of teams, with conflicts between their own expectations and needs and pressures of the professional group, questioning their competences, difficulties in establishing positive relationships with students, parents and teaching staff or external stakeholders, and other problems characteristic from the process of professional socialisation defined as the "threshold period" (Kędzierska 2018). Kędzierska (2018) distinguished three different types of anchoring teachers-novices: by copying, in family obligations and professional position, and by high self-assessment of the starting career capital. In the third type of anchoring "the conviction of their high professional competences and the wish to implement the previously imagined project of self in a professional role provides anchorage for a young teacher" (Kędzierska 2018: 84–85).

As academic teachers working with future teachers we can support them in shaping their own competences. We do not, however, have any impact on the environment of teachers in the school where the student teacher will be employed or the history of their families. As Strykowski (2005) postulates, the subjective nature of competence is its distinguishing feature, since it belongs to a particular person. It is unquestionably a dynamic feature, shaped by interactions with the environment While discussing teachers' competences, traditionally three groups are distinguished: substantive – related to the expert level within the subject they are teaching; didactic – related to the methodological workshop; and educational concerning the manners of working with students in the aspect of approaches and communication (Taraszkiewicz in: Strykowski 2005). Strykowski (2005) enumerates more types of teaching competences, including auto-educational – related to self-development and improving qualifications; competences of assessing curricula and textbooks; control and evaluation; media related to the organisation of the teacher's workshop; communication; educational-methodological, and referring to planning and designing work. Strykowski stresses that the concept of competences is dynamic and this

dynamic is especially present in the teacher's interaction with reality as a result of observing their own work, the effects thereof in students, and in collecting evidence, analysis and reflection on this information (Strykowski 2005). Evidence-based education as an approach based on reliable research and empirical data can and should be used in decision making processes in education, but also in school education – in order to organise effective learning processes. It also covers with its scope the aforementioned auto-educational competences. Evidence-based practices are an important element in shaping teaching competences influencing many aspects of teacher's work such as conscious decision-making regarding teaching, which translates into educational effects and quality of education (Ion, Sirvent 2022).

Theoretical frameworks

According to Breckon and Dodson (2016), evidence can be described as research results, and the use thereof indicates making a decision or a policy based on the best available results or research conclusions. Nelson and Campbell state that "«evidence» covers a series of types and sources of knowledge and information including professional expertise, judgement as well as data and research" (2017: 132).

In educational perspective, evidence, especially in teaching natural sciences, has different sources. They can originate from pedagogical research focusing on the educational process and manners of influencing students as well as empirical data in the scope of the taught subject. The use of both types of evidence is a self-educational competence, which is desirable in the teacher's profession.

Evidence in the scope of pedagogy

According to Cranney and McDonald (2012), evidence-based learning describes a set of approaches, processes, strategies, and teaching methods, with regard to which educational effectiveness has been empirically proven. These characteristics assume that there is "evidence that learning has occurred", which means that this process is measurable. This assumption is criticised by, among others, Hodkinson (2008), who believes that it leads to treating the learning process as a simple "knowledge acquisition". "Learning" effectiveness indicators such as "knowledge" retention and obtaining skills can be, in the light of such an approach, attributed to the effectiveness of a selected strategy and thus teachers' competences and the effectiveness of the school. This criticism, however, concerns a certain extreme. Currently, educational research takes into account the complexity of the educational process considering contextual factors such as the role of a student, the role of metacognition (Mayer 1992), the type of support (**scaffolding** – see: Worrel et al. 2010). While describing evidence-based teaching, Patterson and Klein (2012) state that

it is a diligent and reasonable use of current, best evidence concerning good practices in making decisions in (pre-)designing educational practice.

Anyone practising educational measures thinks about what they are doing. Biesta questions "what they are doing", stating that: "Research cannot provide us with the rules of conduct but only hypotheses concerning intelligent solving of problems. They can only say what has happened in a specific situation and not what will work in any future situation. The role of the pedagogue in this process is not to translate general principles into specific courses of action. It rather concerns using research results in order to make solving problems more intelligent" (2007: 20).

Nelson and Campbell, however, underline that despite a serious debate on "golden standards" of research methodologies, "the most frequently used sources of «evidence» come from teachers' professional experiences and from their co-workers, and not from original scientific research (…) we have to carefully examine the availability, attractiveness and possibility of using a series of evidence coming from practice and in practice" (2017: 132). Also, supported by idea presented by Breckon and Dodson (2016: 28) Davis (1999) emphasise that both in research practice and, primarily, school practice, we need more assessment on the impact of interference in order to increase the use of evidence.

Evidence in the scope of taught natural science subjects in the educational process

Environmental education is based, as are the natural sciences, on observations and experiments which provide evidence on which scientific theories and ideas are created. The latter are then subject to critical assessment by the scientific environment. If the educational process is to reflect the manner of practising a given science, then, teaching what we know is not enough. It is more and more important to educate students and citizens so that they understand why we know what we know and why we believe in science, e.g., presenting science as a way of experiencing (Driveret et al. 1996; Millar, Osborne 1998). Such a change in the teaching orientation requires focusing on:

1. How evidence is used in science to construct explanation, that is, on arguments which combine data with scientific theories;
2. Criteria used in science to assess a selection of evidence and develop explanations (Osborne 2002; Osborne, Erduran, Simon 2004).

It is crucial, since oftentimes development of science leads to ambiguous findings and questioning of theses. Evaluating publications or reports is not easy, since it requires the skill of estimating whether the presented evidence is valid and reliable, differentiating correlations from cause and effect interdependencies, observations from conclusions, and assessment of the reliability of sources of information. These skills seem to be crucial in developing scientific literacy without which it is difficult to be a member of the contemporary society who is able to make conscious and responsible decisions, also in scientific and social issues such as, e.g., vaccinations or climate change.

This article presents results of qualitative research concerning changes in students' (pre-service science teachers) perception of the role of "evidence" in the education process. The analysed group of students comprises students in the final year of master's programmes and "novice" teachers during their first year of working in the profession. First, students participated in theoretical classes on using evidence-based teaching practices[1]. After classes, the first round of interviews was conducted (N = 14). Then, some students conducted classes in schools related to using evidence-based practices and collecting evidence in schools. In this group (N = 7) three persons have already started working in a school, while the remaining four persons were second-year students in a master's programme. At this stage research participants received support from authors of the article concerning planning classes, creating research tools or analysis of the results. We were interested in students' understanding of evidence in the teacher's work. The research questions to which we were searching for answers are:

1. How do the respondents perceive evidence and its role in the educational process?
2. Is the perception of evidence changing when they gain teaching practice?

Methods

Research participants took part in a partially structured interview. The interview structure and the code book (Appendix 1) were agreed on at the project consortium's meeting and were discussed several times and validated by a group of students at Paderborn University. Appendix 1 presents a layout of the code book used to record statements given by research participants; the entire document also included examples and rules of coding. Questions included in the structured part of the interview (Appendix 2) referred to all mechanisms of using evidence described by Breckon and Dodson (2016). Analysis categories directly derive from the evidence conception proposed by the aforementioned duo of researchers. The project group decided to use deductive categories which can be inductively divided into aspects registered in interviews, for example, the "perception of the definition of evidence" was formulated as an open category in order to ensure taking into account the full scope of beliefs and perspectives stated within the interviews.

Attributing all questions to mechanisms of using evidence, as recommended by Breckon and Dodson (2016), made it easier to use them as a comprehensive constructive element of the code tree. Subcodes were added to mechanisms in compliance with

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[1] Students participated in the course (additional, 10-hour course) and Science Education classes (number of hours: 30). The classes covered content in line with the idea presented within the theoretical frameworks of this article and students were familiarised with the basics of pedagogical research methodologies. Apart from the theoretical part, the classes had a practical part – developing and conducting research on a small scale. Teaching internships were undergone in compliance with the requirements of the Regulation of the Ministry of Science and Higher Education. Novice teachers worked full-time. Research participants were second-year students at the faculty of biology teaching, who were willing to participate.

questions from the interview guide. The principles of coding were presented in the code book and supported with examples. The first analysis of interviews helped in its further improvement. The reliability of the intercoder was verified throughout a pilot study and the code book was adapted. In another step, project partners coded several interviews on the grounds thereof. During a consensus meeting, unclear codes were discussed and two subcodes were added. Then, the entire material was coded on the basis of a new version of the code book. In order not to omit important aspects discussed by the interlocutor in interviews, coders could add inductive categories which were later discussed by the group and, as a result, important contents were coded in the entire material. Six main categories (evidence-use mechanisms) were distinguished in the code tree: awareness, acceptance, access and communication, interactions, skills, structures and processes (Appendix 1, c.f. Breckon, Dodson 2016). Participants' answers were categorised and then indications of statements qualified in particular categories were counted and got analysed in depth

Results and discussion

In this part, results are presented in the form of examples of statements given by research participants attributed to particular categories after both parts of classes.

Part I. Interviews conducted after the theoretical part of classes

The category of awareness
This category was almost absent in interviews at this stage of research. References to the "novelty of evidence" were mentioned twice. It seems that research participants did not perceive what evidence is and its nature to be an important element of education. On the grounds of statements given by participants, it can be stated that students have low awareness of the significance of evidence in science and education. Exceptions were noted, e.g., in the quoted statement, in which the research participant draws attention to various types of evidence, among others, anecdotal evidence.

> [Evidence] (…) All scientific data collected as a result of an experiment or observation and generally understood research, is based on reliable analysis and conclusions are drawn on the grounds thereof. There is also anecdotal evidence, own experiences – they cannot be used with regard to the entire population, but they can constitute evidence in a given, specific situation.

On the other hand, this category includes a subcategory of "the role of evidence for a school", which partially corresponds with other categories such as, e.g., 2d – evidence in a school. Evidence significance was mentioned in statements such as:

It is important for the teacher, since it allows them to grade and provide feedback.

Evidence can be used in a school, e.g., scientific evidence in pedagogical or didactic re-search can allow choosing a more adequate teaching style or method. Furthermore, the use of scientific evidence in teaching and showing this evidence to students can increase their engagement – understanding the sense of science itself.

The category of acceptance

This category was the most numerously represented after the first part of research. Apart from the significance of evidence in school for making decisions, statements on the role of evidence in learning were given, for example:

The research can be repeated and whether something actually exists or existed can be verified many times. Confirmability – a larger group of competent people agrees with the evidence, people who are actually experts in the area.

The category of access and communication

After the first part of the classes, participants rarely spoke in more detail about preparing to use evidence in school practice. Example answers that referred to this category:

(…) we will see, after the apprenticeship I felt well-prepared, but from September I will deal with it myself and we will see how it is going to be in reality.

The training (…) has introduced a certain manner of thinking about teaching not only as transferring information to students, but also as collecting information on effects of teaching and forwarding it. I also (…) learned that I can conduct teaching research myself, I know how to plan, conduct, analyse and share results thereof with other persons. The training showed me how important it is to use evidence during lessons.

The category of interactions

This category concerned students' interactions with evidence. Answers which were given most frequently concerned using scientific research. Nevertheless, participants' answers included references to arguments as statements containing evidence.

I prefer hard scientific evidence supported by many studies and published articles. There are, however, topics in which I allow discussion and questioning scientific knowledge provided that proper arguments are presented.

In the event I allow discussing scientific evidence I require students to support their theses with relevant arguments and evidence, I do not provide them with specific instructions how to do it, but I require their arguments to meet certain criteria (e.g., they cannot be anecdotal evidence). Students have to rely on sources which can be considered reliable and they have the ability to assess sources of information, which they have gained during previous lessons.

The category of skills
Answers to this part of questions in the first stage of research were usually succinct and participants were not willing to elaborate on this topic. One of the most elaborate answers was the following:

> I think that I am on a good path to assess the reliability of scientific articles, I know where I can verify if a given newspaper is worth attention. (…) I can also assess used methods and statistical analysis.

The category of structures and processes
Within this category we have distinguished several subcategories, which included: task areas of a school with a specific emphasis on evidence, the role of evidence in teacher's work in the aspect of seniority (gaining professional experience), making decisions on the basis of institutional policy/guidelines and restrictions.

This category also was not numerously represented. The experience of research participants came only from their teaching apprenticeship which were limited in terms of time and organisation. Answers indicating the role of the headmaster and teachers-educators who should, in the respondents' opinion, be led by evidence, were given. Example statements illustrating the role of evidence in areas of teacher's work:

> This is a pedagogical area, the entire didactic activity related to teaching.

> Assessment, students' mental health and taking care of their well-being, school work organisation (e.g., a school day), cooperation with institutions, because an institution can offer more effective methods (…). In general, for the school and not for the teacher themselves.

Answers indicating the significance of evidence for a wider group of school employees:

> Probably for all: a headmaster, teachers, students, secretaries and the entire technical staff – without them the education process would not exist.

> Primarily for teachers, for the headmaster, (…) for the school pedagogue and psychologist, and of course for students are also important, even if initially they are not aware of it.

Part II. Interviews after the practical part of classes

The category of awareness
Similarly as in the first part of research, the category of "uncertainty of evidence" was rarely represented. An example statement from this scope:

> [Publications] can be socially harmful and not efficient, e.g., autism caused by vaccines – this dude, who conducted paid "scientific research", Andrew Wakefield – this is unacceptable.

Again, the novelty of evidence was not mentioned at all. In the part concerning what evidence is and what its role in a school is, the majority of research participants mentioned the role of evidence in selecting teaching methods and relevant materials.

> On the one hand, this means literature and using, e.g., scientifically confirmed evidence whenever a biological novelty comes up and fits the lesson, it is nice to mention that it has been scientifically proven. Also experiences of others – conversations with friends, comparing experiences, what worked and what did not.

There were also statements emphasising higher awareness of how evidence should be used in schools.

> As far as headmasters and teachers are concerned, having concrete scientific and episodic evidence can result in the headmaster's influence on teachers going in the right direction, in relationships between teachers it can contribute to improvement thereof, and in relationships with students it gives the possibility of the highest awareness possible and developing proper attitudes.

The category of acceptance
Similarly, as in the first part, also after the practical part the understanding and perception of evidence was very numerously represented in statements given by participants, in total it was mentioned 23 times in 5 interviews. Example statements:

> I understand evidence as facts, phenomena, certain circumstances which have been confirmed with research. These are not hypotheses or assumptions but something which has been to a certain extent confirmed, proven. Evidence is what we use every day, what helps us function and discover the truth. It helps me take a position.

> Evidence must also be reliable, i.e., obtained in a properly conducted research on a large group of respondents, with unambiguous results and clear conclusions drawn.

Evidence in everyday life – this category is very often mentioned in interviews – came up 26 times. Several examples have been provided below:

> Definitely in medicine, and it does not only concern doctors, but also what people believe in, e.g., evidence plays a significant role in the context of vaccines, additionally it plays an important role in education in which methods are chosen or the entire system is established.

> It is easier to have a discussion on the issue of ecology, which is full of inaccuracies and contradictions, even with our own environment, when we have the evidence and scientific data.

> But I also think I would try using influencers – why would they rely on evidence? Because they reach a huge number of people and if they preach senseless ideas, they can cause social damage.

The categories of access and communication

In the second part of the research, this category was the most numerous, 11 statements referring to the assessment of preparation to use evidence were coded. Examples:

> She prepared me very well, taught me how to recognise reliable evidence, distinguish facts from opinions, and obtain evidence on my own, if I do not have it in my surroundings.

> I reckon that I am able to independently plan and conduct research on a small scale, the more so, since I have already had some experience while planning and implementing the project (…). Planning and conducting such research requires a lot of work and time, but I think that after an accurate analysis of each step. (…) I am prepared for such action in substantive and practical terms.

Some participants mentioned related problems, e.g.:

> I believe that I can plan and conduct research on a small scale (…). But there are many factors which should be remembered, guidelines which should be followed, conditions which cannot be forgotten, so I think that I would need more tests to be sure that I can do them.

> I have a solid foundation. However, I do not feel confident in this area. My awareness has certainly increased significantly.

The category of interactions

In this category 11 statements indicating the type of interactions of students with evidence were coded. Recipients paid attention to the role of disciplinary evidence as well as to the ability to distinguish scientific evidence from fake news.

> I make them [students] aware of the significance of following evidence and supporting their own ideas with proper evidence, I teach them how to verify evidence and design experiments so that they can create evidence themselves. Thus, we look through various sources, among others, popular science articles, to check which evidence can be considered reliable. I also teach them how to use Google Scholar.

> The use of evidence is apparent, e.g., when the topic is discussed in a classroom, where students use arguments. (…) It is very important that the students collect evidence material themselves, try to answer problematic questions.

The category of skills

At this stage of research, there were numerous references to this category. The category itself covered many subcategories. In the subcategory "searching for evidence" (5 statements), books and scientific articles were most frequently enumerated.

3 statements regarding the use of evidence in the teaching process were classified in the subcategory "scientific evidence from the area of pedagogy". For example:

> During classes students often have the possibility to verify evidence on their own, for example by doing experiments. (…) As far as generating evidence is concerned, I am collecting evidence mainly from scientific works, by conducting classes or preparing presentations, but also by participating in seminar classes. In Oxford debates, the use of evidence is also necessary.

Evidence in learning general science was given only 2 times. These statements concerned sources and the issue of relying on a person who is an authority figure in a given area. For example:

> I am trying to use films made by people with relevant authority and knowledge, I also show students the websites which I have checked before and know are trustworthy.

Six statements were noted in the subcategory "assessment of articles". Some respondents claim that they are able to assess scientific articles, and some do not. Usually in the case of assessment categories, attention was paid to the number of citations, used methods and sample size. Example statement:

> I believe that (…) I can recognise whether a given scientific article is reliable and whether it is worth using. I look at the number of citations, the year of publication and how much in a given field could have changed during this time, whether described methods can be repeated and are presented in a coherent manner, whether the article describes and presents used research tools, what does research and control trials look like, and have they been randomised. In the case of articles on education, groups can be purposefully chosen, if justified.

7 statements were noted in the subcategory "planning and conducting research". The statements were made in all interviews. Some respondents feel that they plan such research well, whereas others do not assess their skills this way. All claim that they are able to perform such a task, but sometimes with small support. For example:

> I have conducted experiments on a small scale, where in one group I use another method and I compare effects with the control group, which allows me to verify if a given method, during given classes, will work on a specific group or not. And again, a conversation with teachers I know and exchanging experiences.

> Yes, I think. However, I would rather consult the results with an experienced person.

In the subcategory concerning the scope of using evidence, 9 statements were noted and all concerned planning and doing experiments, or selecting teaching methods.

> In the situation of checking knowledge of my students and analysing their work during a lesson e.g. by checking how they designed the experiment. Additionally, I note down my own observations regarding my work during a lesson, methods I have used and how they worked.

> Selection of a specific method or a form of work is based on evidence of the most effective method which will work during given classes.

The category of structures and processes

Statements in this category were quite numerous. Within the subcategory concerning the school's task areas with a consideration of the use of evidence, 16 statements were given. Also, perception thereof is very wide (it concerns not only teachers but also parents, head-masters and aspects such as: teaching, making decisions, e.g., giving awards, as well as interpersonal relations, etc.). Examples of statements:

> In assessment I use, e.g., research conducted on the assessment method's impact on students' motivation and engagement or willingness to study the subject.

> I usually use teaching materials to plan the contents of the lesson, but I also use core curric-ulum and primarily new information (the newest scientific articles) so that given information is up-to-date (unfortunately, sometimes the knowledge provided in core curriculum and text-books is not fully updated).

Evidence in the aspect of teaching seniority was mentioned in interviews four times. All statements indicated change in perception of evidence, which has been noted by par-ticipants. Example:

> Initially, it seemed very difficult and complicated, but I learned how to use evidence and how to find evidence that can be used. (…) I also learnt how to ask questions to engage students in searching for evidence themselves.

In the subcategory concerning the role of evidence in making decisions on the grounds of policy/guidelines, 4 statements were also noted. The one exceeding the aforementioned information, since it referred to the entire group of interactions between all participants in a school life, has been presented below:

> Headmasters who have knowledge and evidence concerning critical thinking transfer this knowledge to teachers and require working in this system with students. They can also in-troduce a specific type of work for the entire school on the basis of held evidence – as in the case of the obligation to work with the project method next year. In relations with teachers it can result in mutual support, exchanging knowledge on a given method or tool and help in distinguishing facts from opinions, which is difficult in work between teachers, since teach-ers are a very demanding and specific professional group.

Institutional limitations in the scope of using evidence in education were mentioned in interviews only twice. One statement underlined the significance of the fact that evidence should be widely used. The other concerned connecting school funding with various evi-dence and evidence in assessment of the quality of school's work by external institutions.

Distribution of indications regarding classification of statements to particular categories in both research groups (after the theoretical part and after the practical part) was presented in Table 1 and Figure 1.

Table 1. Distribution of indications regarding classification of statements to particular categories

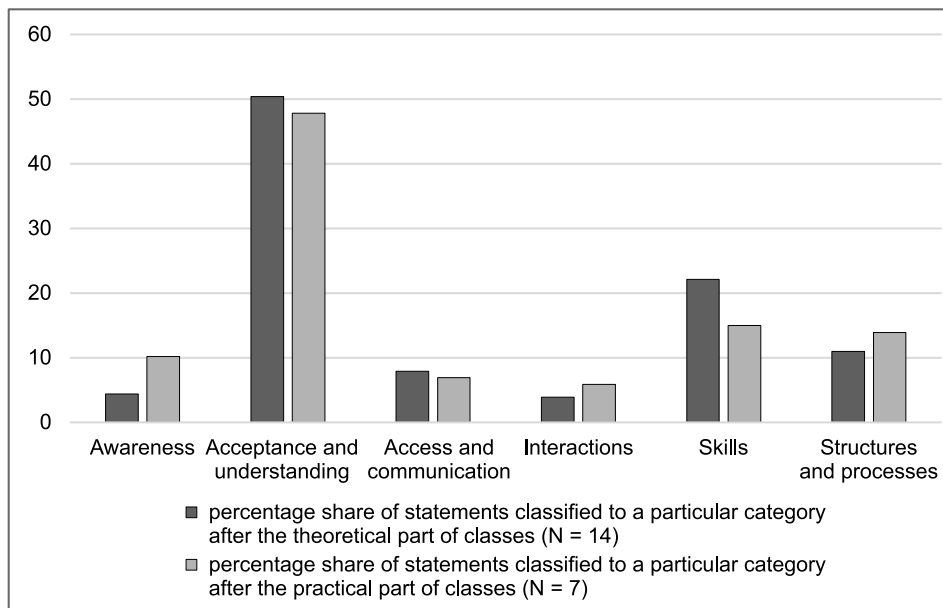| Category	The number of statements classified to a given category	
	after the theoretical part of classes (N = 14)	after the practical part of classes (N = 7)
Awareness	10	19
Acceptance and understanding	114	89
Access and communication	18	13
Interactions	9	11
Skills	50	28
Structures and processes	25	26
Total indications	226	186
Average number of statements per participant	16.1	26.5

Source: own study.

Figure 1. Percentage share of statements classified to particular categories after both parts of the research

Source: own study.

Figure 1 does not fully convey the essence of differences between analysed groups, however, it does indicate certain trends. For example, after the theoretical part of classes, participants paid a lot of attention to skills related to searching for and using evidence, especially in understanding of the material taught. After the practical part, a huge sharing of answers among participants regarding awareness of what evidence is was observed. The second area of differences is the category of structures and processes. In this category, it is worth noting the fact of extending understanding of the significance of evidence and the use thereof while making decisions, planning activities, and within entire task areas that would require relying on evidence to a greater extent.

Conclusions

Research concerning evidence-based practice in non-medical education is quite a new trend. Promotion of evidence-based practice by the administrators of public education is also noticeable. Effective implementation of these practices depends on many factors including, among others, initiative, style of making decisions and atmosphere of cooperation. Personal and interpersonal factors and collegial decision-making are also of great importance (Ion, Sirvent 2022).

The conducted classes were aimed at equipping students not only with the working tools of a teacher relying on evidence, but also showing the role of evidence in practice and building trust in evidence-based practices. The practical part, providing the opportunity of testing own hypotheses and conducting action research, proved to be "a trigger" to thinking about evidence. Research participants entering the school environment, faced the situation of dealing with a whole range of tasks, challenges and difficult decisions which they have to make. After the theoretical part, the majority of research participants saw the role of evidence primarily as a tool to teach material in the scope of natural sciences, and designed scenarios of classes that to a great extent took such evidence into account. After the practical part, all participants emphasised the complex nature of evidence and the significance thereof for the functioning of a school. They emphasised the role of "using evidence" as tools as soon as in early education. For example, they indicated the necessity of developing skills of assessing the reliability of sources of information by, e.g., distinguishing fact from opinion. They emphasised the role of evidence in the teaching process itself – for a student, how evidence is able to change the student's perception of their own learning process and their own progress. In interviews conducted after the first part, the most-often indicated area, in which it is necessary to use evidence, was medicine and everyday activities such as cooking food or watering flowers. After the practical part, the share of other areas of life increased – including education in the broad sense of it (also among people engaged in the process, as well as areas of school's functioning that require evidence). After the practical part, the number of indications concerning the role of evidence for the society increased, including information on the COVID-19 pandemic,

harmfulness of anti-vaccination movements, the anthropogenic climate change, etc. After the theoretical part, respondents indicated the necessity to use evidence for education mainly with regard to students – so that they were able to "avoid fake news", or so that a teacher could assess the students reliably. There were also answers concerning the use of evidence in order to prepare materials for classes. After the practical part, teachers noticed that the functioning of a school could be "improved" if the decision-makers, e.g., the headmaster, took evidence into account.

After the theoretical part, respondents indicated the necessity to collect evidence, e.g., when conducting experiments. After the practical part, participants gave specific examples of interactions and indicated applications and methods, such as holding debates and presenting arguments, but also encouraging the independent search for evidence in order to solve a given problem, e.g., why is it important to brush one's teeth?

Table 1 shows the general distribution of qualifications of statements to specific categories without showing the statements. For example, after the practical part, the majority of respondents made very general statements, e.g., that they are able to assess the quality of scientific articles, but they were able neither to provide nor describe the criteria for this assessment. Sometimes they gave the number of citations as an indicator of the article's quality. After the practical part, the majority of respondents indicated not only citations, but also took into account the plan as well as the assessment of the research and the reliability of the author and their professional experience in a given area along with the logic and coherence of presented arguments.

The value of the presented results consists in showing the role of practice and measures for internalisation of the concept of evidence in education. The in-depth internalisation also took place in the group of students whose teaching practice was limited to 30 hours, during which they were designing and conducting research on a small scale, assessed scientific articles and observed their colleagues conducting their own research. During the second stage of research the entire group consisting of 12 persons in total (not all persons participated in interviews), created a small community for purposes of learning from one another, discussing teaching issues and supporting each other in educational and research activities. The presented research shows the value and some of the necessary conditions under which implementation of evidence-based practices in schools should happen. The school atmosphere should be taken into consideration to better ensure that the teachers' position is reinforced and that the making of courageous decisions based on evidence is encouraged with regard to improving teaching practices, engaging in experiments and collecting evidence. The key factor of success is a school atmosphere in which teachers are encouraged to show their personal initiative, in which collegial support as well as the presence of a discursive approach to education and to the making of decisions, and in which responsibility for defining, implementing and supervising the teaching and school learning strategy is stimulated (Khasawneh, Omari, Abu-Tineh 2012; Duyar, Gumus, Bellibas 2013; Ion, Sirvent 2022).

The presented research results can serve as guidelines for modifications in the process of educating future teachers. Enabling students to take educational actions in a dual role of a teacher and researcher had a positive impact on their perception of not only the role of evidence, but also better and more in-depth understanding of the complexity of processes in schools. This situation can be explained by, among others, introducing the factor of reflection not only on the understanding of evidence, but also on actions taken. The actual impact of reflection on pedagogical content knowledge was also stressed by Park and Oliver (2008). Tait and Boulton-Lewis (1993) likewise proved that introduction of action research and reflection on the use of teaching aids changed the perception of teachers and their understanding of manners of using such aids. Therefore, it seems justified to introduce the principles of evidence-based practice and conducting action research and reflection (including self-reflection) in curricula of educating future teachers as elements of their "teaching equipment".

Appendix 1

Structure of the code book used to code statements given by research participants

Category	Definition
1. Awareness	Developing awareness and positive attitudes towards the use of evidence
Uncertainty of knowledge/ uncertainty of evidence	Concerns the possibility of changing knowledge/evidence over time
The role of evidence for a school	Awareness of the role of evidence for a school
Novelty of evidence	Concerns differences or opinions on the novelty of evidence
2. Acceptance and understanding	Building mutual understanding and communication regarding issues which are important for the policy and types of evidence necessary to respond thereto
Understanding/perception of evidence	Understanding of evidence, e.g., data necessary to develop evidence, research project, evidence format, evidence examples, etc.
Evidence in everyday life	Areas/themes of everyday life and private life where evidence is important
Evidence vs personal beliefs	The relation between evidence and personal beliefs
Evidence in a school	Evidence in a school, in general
Evidence in a school in the scope of exact science (CK – content knowledge)	Evidence concerning the scientific area (see: Kattmann et al. 1997; Kattmann 2007) with a particular reference to the knowledge on subjects/contents, etc.
General education/ psychology (PK – pedagogical knowledge)	Evidence concerning general aspects of education and psychology

Category	Definition
Scientific education (PCK – pedagogical content knowledge)	Evidence concerning science in the area of education/pedagogy (see: Kattmann et al. 1997; Kattmann 2007) with a specific reference to subjects/methods, etc.
Comparison of various evidence	Differences in evidence quality
3. Access and communication	Ensuring communication and access to evidence
Preparation by training (professional development)	Aspects concerning preparation ensured throughout the entire training programme
4. Interaction	Facilitating interactions between decision-makers and scientists
Students' interaction with evidence (process)	Occurrence of students' interaction with evidence
5. Skills	Supporting decision makers in developing skills of obtaining access to evidence and understanding thereof
Searching for evidence	The process of searching for evidence
Evidence in exact sciences	Searching for evidence concerning a scientific area (see: Kattmann et al. 1997; Kattmann 2007)
Pedagogical sciences	Searching for evidence concerning areas of educational/ pedagogical sciences (see: Kattmann et al. 1997; Kattmann 2007)
Assessment of articles	Personal perception of the possibility of assessing the quality of a scientific article
Independent planning and conducting the research on a small scale	Personal perception of the so-called skill of planning and conducting research on a small scale
Using evidence in lesson preparation	All statements concerning the use of evidence in lesson planning
6. Structures and processes	The impact on structures and processes of decision making
School's task areas with a particular consideration of evidence	Areas or people in a school who have a special need to work with evidence
Evidence in the aspect of teacher's seniority	Differences/changes over the years of working as a teacher (even as a pre-service teacher)
Making decisions on the basis of the policy/guidelines	Decisions based rather on the policy/guidelines than on evidence
Institutional limitations	Institutional limitations and aspects which facilitate or hinder evidence-based practice

Source: Product developed by members of the consortium of the Erasmus Plus project (KA203 financed by the European Union, contract number 2019-1-NL01-KA203-060339) Research in Teacher Education (RiTE). Six main categories (evidence-use mechanisms) were based on the framework proposed by Breckon and Dodson (2016).

Appendix 2

Interview questions

1. How do you understand evidence?
   – Can you give examples of evidence?
   – What are the characteristics of evidence in these examples? What does it refer to, what is it related to?
   – What other characteristics of evidence do you know?
2. In your opinion, where evidence plays the main role in everyday life?
   – In what professions? (e.g., a doctor, etc.)
   – In what fields? (e.g., politics, etc.)
   – In what areas? (e.g., vaccines, climate change, etc.)
3. Can you give examples of using evidence in your everyday life?
4. What is the role played by evidence in a teacher's profession?
   – What kind of evidence do you use in selecting assessment methods?
   – What kind of evidence do you use in planning your lesson?
   – What kind of evidence do you use in planning methods, etc. to be used during your lesson?
   – What kind of evidence do you use while conducting lessons with students?
   – Do you instruct students to collect evidence?
5. How do you assess the role of evidence for a school?
   – In what areas of school's activity do you think evidence is important?
   – For whom evidence in a school is important?
6. How well has the training prepared you to deal with evidence in a teacher's profession?
7. In what situations are you generating/observing/collecting evidence during classes? Please describe/answer.
   – Do you believe you are able to assess the quality of scientific articles?
   – Do you believe you are able to plan and conduct research on a small scale on your own?

Is there anything else you would like to mention?

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