METODOLOGY OF QUANTITATIVE RESEARCH APPLICATION IN CONTEXT OF BRANCH DIDACTICS

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Abstract: The article presents an overview study of the methodology of quantitative research focusing on the research methods most often used in the field of branch/subject didactics. The authors approach to this issue is based on a conceptual analysis of the interconnection branch didactics with general didactics, and on the conceptual analysis of the branch didactics historical development. In this context, the authors' key attention is paid to methodology of descriptive, correlation and causal-comparative research.

Key words: education research, quantitative research methods, general didactics, branch/subject didactics.

METODOLÓGIA APLIKÁCIE KVANTITATÍVNEHO VÝSKUMU V KONTEXTE ODBOROVÝCH DIDAKTÍK

Abstrakt: V článku je spracovaná prehľadová štúdia metodológie kvantitatívneho výskumu v zameraní na výskumné metódy najčastejšie používané v rámci odborových didaktík. Autorky vychádzajú jednak z koncepčnej analýzy prepojenosti odborových didaktík so všeobecnou didaktikou a jednak z koncepčnej analýzy historického vývoja odborových didaktík. V prezentovanej prehľadovej štúdii sa ťažiskovo venujú metodológii popisného, korelačného a príčinno-komparatívneho výskumu.

Klíčová slova: pedagogický výskum, kvantitatívne metódy výskumu, všeobecná didaktika, odborové didaktiky.

1 Introduction

Research is one of many means by which people seek answers to their constantly rising questions, may they be personal or professional in nature (Mouly, 1978). If the information we collect to help make a decision is of substandard quality or accuracy, that decisions will reflect the aforementioned deficiency. The stated is usually a consequence of the fact that information may be collected from sources most convenient and comfortable to us and the collection of which is done in an unsystematic or subjective manner. However, answers to questions of a professional nature require gathering of correct information, sources of which must be scrupulously chosen and verified, i.e. valid and reliable (Kerlinger, 1973; Cohen et al., 2018). The best way of obtaining such information is to use scientific methods. In this context, it can be stated that a scientific method is a systematic and objective procedure for finding answers to our (research or professional) questions; it is a specific strategy used to resolve the problems behind the given questions.

In the field of education, research involves a number of areas including but not limited to teaching and learning processes, instructional strategies, classroom environment, academic subjects, curriculum design, students´ performance and learning achievements, teachers´ proficiency and competence profiles. In general, educational research may be perceived as an application of the scientific approach using various research methods to study educational problems. In other words, it refers to a systematic attempt to gain a better understanding of educational process to improve their efficiency. Educational research has two aims: the primary and the ultimate one (Ary et al., 2010). The primary purpose of educational research is to deal with the issue which is the subject of the research, to broaden and expand the existing body of knowledge by providing solutions to different problems in pedagogy while improving teaching and learning practices. The ultimate aim of educational research is linked to the target groups of research and is more overarching (Gavora et al., 2010). It is the aim to discover general principles and interpretations of human behavior, to explain, predict and control events in educational situations. Based on the scientific theories formulated within education one can provide educators with the knowledge that will enable them to achieve their educational goals using the most appropriate methods. As Lopez-Alvarado points out (2017), educational research should have three objectives, these being exploration of issues by finding answers to questions (for academics), sharing policy (for policy makers, e.g. relationships between education – work – and training), and improving practice (for practitioners). In each case it should be based on critical, reflective and professionally oriented activities.

Currently within the branch didactics a global tendency is to support research carried out in their frame by means of quantitative methods. This has been a consequence of the effort "to strengthen scientific aspects of the research". The key problem in this context is to find a balance between quantitative and qualitative research by highlighting their compatibility rather than rivalry within a single research project (Brezinka, 2005; Cohen et al., 2018). As Petlák points out (Petlák, 2019) the stated tendencies "to strengthen scientific aspects of the research in education" not always bring desired relevant results. And this regards mainly branch didactics, where the results of the research should be of practical features, they whould represent practical branch didactics. A solution is to use so-called "research-question-based thinking mode" in choosing the research design, tools, analytical modes, etc. that seem to fit the research question best or serve the purpose of supporting or refuting the hypothesis the most (Cohen et al., 2018).

Following the, as it has been stated not always completely adequate tendencies, hereinafter an overview study of the methodology of quantitative research focusing on the research methods most often used in the field of branch/subject didactics is presented. The authors approach to this issue is based on a conceptual analysis of the interconnection branch didactics with general didactics, and on the conceptual analysis of the branch didactics historical development. In this context, the authors' key attention is paid to methodology of descriptive, correlation and causal-comparative research.

2 Research in teaching and learning

In the field of education, research involves a number of areas. The same can be stated regarding educational sciences too, which cover many different pedagogical disciplines and subdisciplines that refer to the topics, institutions, processes, and results of education and training (Terhart, 2012). Branch didactics, or subject didactics, is the science of subject-specific learning (Cramer & Schreiber, 2018). It represents an independent and institutionalized field of research, theoretically and methodologically related to the corresponding scientific disciplines (subjects taught at school) and educational sciences. It represents both school subjects and learning fields as well as their protagonists in education and vocational training, research and professional practice (Heitzmann & Pauli, 2015). Subject didactics, whose pivotal feature is optimizing discipline-related learning processes, has historically developed to represent teaching practice and normative theory. It can be understood as a bridge between subject-specific academic knowledge and the pedagogical field of action. It is not committed to a mode of distanced observation but to configuring and improving teaching and learning processes.

In the United Kingdom and English-speaking countries large branch/subject didactics does not exist. However, subject education as a term is often used and some domain-specific didactics (e.g. curriculum theory, instruction research) are established (Meyer, 2012). In continental Europe didactics has been established in the sense of general didactics. In many EU countries including Scandinavia, Germany, Switzerland, France, Spain, Russia, the Czech and Slovak Republic both domain-specific and subject didactics have come to exist.

To offer space for dialogue about the many research traditions in Europe and to conceptualize the relations between learning, teaching and knowledge content – which have shaped education and training for the younger generations – the European Educational Research Association (EERA) was established in 1994 (https://eera-ecer.de/about-eera/). The purpose of this non-profit organization is to promote science, research, education and training in the academic field of educational research for the benefit of the education and training of the European citizens. In addition to supporting collaboration in educational research throughout Europe, the EERA tries to improve research quality and offer independent advice on educational research to European policy-makers, administrators and practitioners. EERA activities are based on network collaboration structured into 33 specific fields of educational sciences. From the viewpoint of branch didactics, the key one is the network field called NW27 *Didactics – Learning and Teaching*. The field of NW27 *Didactics – Learning and Teaching* deals with discourses about teaching purposes and methods, educational content, debates about conceptual frameworks to characterize content-related social practices occurring in the classroom and during curriculum construction processes. The field appears to have complex relations between professional science developed by (and for) the practitioners themselves and academic science (focusing on teaching and learning practices). It tends to be segmented down to school subjects or knowledge domains organized in the curricula, which is relevant to branch/subject didactics (e.g. *Fachdidaktiken* in German speaking-countries, *Didactique des disciplines* in French-speaking countries).

Cooperation, sharing information and experiences in the EERA NW27 may be perceived as contribution to international dialogue that described the differences between didactics and curriculum theory in the 1990s. The dialogue was held by European and North American researchers as a result of the fact that didactics was elaborated in German-speaking and Northern countries and curriculum theory was developed in English-speaking countries (Ligozat & Almqvist, 2018; Hopmann & Riquarts, 2000). What is more, work carried out in EERA NW 27 has strengthened the mutual understanding of the conceptual frameworks used in Europe to study teaching and learning in the classroom from the perspective of educational content. Nowadays, this research is characterized by the growth of empirical research on classroom actions and discourses, classroom practices in relation to the national curriculum requirements in terms of subject and/or competences, and teachers' professional development through the reflexive analyses of classrooms practices. Such type of empirical research is often carried out from the multiple perspectives of branch/subject didactics.

General didactics has been subject to the influence of international surveys co-ordinated by the OECD, notably the cyclical survey carried out as part of the Program for International Student Assessment PISA (https://www.oecd.org/pisa/). Within this program general didactics attained the rank of the most important science in the context of learning, teaching and teacher education. In additional, thanks to the partial focus of the PISA surveys on student achievement in math, natural sciences, digital skills, technical literacy the status of the relevant branch/subject didactics has also increased. According to Zierer and Seek (2012, until the PISA program was launched general didactics had a nearly undisputed position. After the release of the first results of the PISA study in 2000 general didactics met with increasing criticism in the public leading to heightened importance of the empirically oriented sciences of teaching and learning, pedagogical psychology, subject didactics and new perspectives and phenomena still in progress.

3 Quantitative research design

According to Cohen et al. (2018) all genuine knowledge is based on sense experience and can only be advanced by means of observation and experiment. Due to the role positivism plays in scientific thinking we can freely apply the methodological procedures from the natural to the social sciences when we carry out research in this field (Duncan, 1968; Giddens, 1975). Determinism, empiricism, parsimony and generality all support the standpoint that social events have causes which may be studied and experienced by evidence, and subsequently simplified and generalized.

Educational research is no different from any other type of research in that from a traditional viewpoint, as in any other social or natural science, phenomena may be studied using quantitative research methods. In the interpretive view, however, educational research may ideally be carried out using qualitative research methods, as each person is a unique individual shaping his/her own unique ungeneralizable world. It is up to the investigator and his approach to social science, may it be subjectivist or objectivist, to decide what kind of phenomena in educational research s/he will study and by what means. An objectivist will decide for a predominantly quantitative analysis using such tools that objectively measure the reality, which independently exist outside us. Some of the most common quantitative data collection techniques include surveys and questionnaires, interview, observation, document review and probability sampling. The objectivist researcher must possess well-developed computational as well as mathematical skills to be able to treat and analyse the data received, which is essential to answer the research question. A subjectivist will opt for qualitative research analysis making use of data collection methods such as face-to-face interviews, focus group discussions, observation or documentary analysis.

Despite the fact that educational research is essentially research per se, it must be highlighted that the subjects of the research project are often pupils or students under 18, which brings ethical considerations to the forefront. In fact, as Cohen et al. (2018) state, sampling, reliability and validity are key matters in research and without due attention to them the research will be rendered worthless. Therefore, access to data collection from the individuals studied must be duly taken care of and the success of data analysis resulting from grounded suggestions based on the results gained may provide priceless information to provide better education for the generations to come.

Quantitative research helps to analyse the world in quantifiable terms and draw objective, unbiased and generalizable conclusions thus aiding others solve similar or identical problems to the ones investigated by the research in question. To reach this goal one must choose the right design to research a problem so that, once it is ready, the research is not threatened by internal and external validity or reliability issues to make it invalid or futile in the first place (Chráska, 2016). Thankfully, advances in the development of the study of research methodology enable us to choose from a wide variety of research designs in order for us to be able to answer old and newly emerging questions (Hendl, 2012).

In quantitative research we differentiate two main types of design, which are *non-experimental* and *experimental design*. The main difference between the two lies in the fact that the former relies on the analysis of already existing factors without a desire to maneuver with them while the latter attempts to manipulate one variable to see its result(s) on another one. Both types of design have their respective advantages and disadvantages, however, for the sake of higher validity and reliability it is advisable, if possible, to opt for experimental design. Nevertheless, in order to gain confidence in doing research, start-up researchers are encouraged to carry out non-experimental design due to its simplicity and lower level of erroneousness.

Despite the numerous differences between non-experimental and experimental design, both line up behind the same research process baseline, which, according to Mertler (2018), consists of the following steps:

1. identification of the research problem,
2. statement of the hypothesis,
3. review of the related literature,
4. development of a written literature review,
5. development of a research plan,
6. data collection,
7. data analysis,
8. drawing conclusions and recommendations,
9. writing up the final report.

3.2 Non experimental research design

Non-experimental research is valuable in that the right description of variables may shed light on the correct understanding of the state of affairs at a given moment thus enabling the researcher to draw statistical conclusions about the reality being described (Lowhorn, 2007). Mertler (2018) differentiates 3 types of design, namely:

a) descriptive,
b) correlational and
c) causal-comparative.

Both correlational and causal-comparative research are grouped into one research design by Cohen et al. (2018), namely *ex post facto research*, as they both study the antecedents of currently existing situations and the role of the variables is also identical (the present effect being the dependent variable, the possible cause being the independent, uncontrollable variable).

a) Descriptive research

Descriptive research is supposed to describe and interpret the current status of individuals, settings, conditions, or events as they exist in their natural setting (Mertler, 2018). The difference between observational and survey research, which belong here, lies in the former describing frequency, accuracy, intensity, proficiency or mastery of a behaviour while the latter ventures to describe traits of groups or a whole society (ibid.). Mertler (2018) further differentiates survey research into *descriptive survey, cross-sectional and longitudinal.* The latter is particularly suitable and useful in educational research as we may study how different pupils behave in a given year (*trend study*) or how a characteristic we focus on in a given group changes over time (*cohort and panel study*).

Questionnaires

Gaining indirect data via *questionnaires*, which are essentially the "self-reports of individuals" (Tsokalidou, 1995), is the main data collection method in *survey research*. The three types of information gained by questionnaires as to Dörnyei (2007) are answers to factual, behavioural and attitudinal questions. This type of research must, at the offset, address sampling, designing and administering issues. Once the researcher opts for either probability or non-probability sampling, out of which the former is always more advised in quantitative analysis, s/he may address the next question regarding design. As Cohen et al. state (2018), one thing is for sure, the questionnaire is designed with the analysis in mind. The researcher may go for more elaborate methods, such as factor analysis or structural equation modelling or easier methods, for example simple frequencies, percentages or correlations. The questionnaire must include questions to answers which play into the data needed to carry out their analysis. Question types, according to Cohen et al. (2018), fall into the following categories:

- dichotomous questions,
- multiple-choice questions,
- rank ordering,

- rating scales,
- constant sum questions,
- ratio data questions,
- open-ended questions,
- matrix questions,
- contingency questions.

To increase response rates a pre-survey letter advising respondents on an upcoming survey to take part in should be sent out. The cover letter is a widely-accepted must when sending out questionnaires, as without it the recipient will not know what they are supposed to do, for whom and with what purpose. To prevent any mishaps on the field and increase internal reliability, it is strongly advised to pilot the questionnaire (Dörnyei, 2007). Another suggestion worth mentioning is the inclusion of an incentive, if feasible, in return for completed questionnaires.

In quantitative research we arrive at nominal, ordinal or interval data (ibid.). In order to collect valid data, surveyors may build in data validation checks, which work well with online data collection tools, and some are feasible only using web-based data collection tools. Such state-of-the-art examples would be geotagged photo questions, audio questions or signature questions (Garcia, 2018).

Data collection and analysis

Collection and analysis of data in case of survey research is an elaborate endeavour. With the advancement of the use of online data collection tools we have a number of options to choose from: we may wish to administer the survey directly, call the participants, interview them personally – provided we have considerably funding for the research, send them an e-mail or engage them in a web-based survey. The latter means is the most cost-effective, saving as much as $1051 and 25 hours of work time on a sample size of 300, according to Archer (2003). The trade off, however, is a decreased return rate of the responses by as much as 50 %.

The online world or computer-based technologies not only provide us with state-of-the art data collection but also data analysis tools, speeding up the process and making it possibly even more precise or human-error free than the manual way, using a pen and hardcopy sheets of paper. The analysis of the data takes place using *statistical procedures*, including frequency distributions, descriptive statistics, correlations or group comparisons. When reporting descriptive results, wanting to describe tendencies or the variability of scores, we use descriptive statistics, providing mean, range, standard deviation and the number of participants (Dörnyei, 2007). The easiest way to do this is with the help of the Statistical Package for Social Sciences (SPSS), or Statistics Solutions (2021), for short. A great advantage of software-assisted analysis is the easiness to deal with missing data, which includes list wise deletion, mean/median/mode imputation, Last Observation Carried Forward or resurveying (Shatia, 2018).

Examples of computer assisted software to analyse research results include NVivo, ATLAS.ti, MAXQDA and other types of Computer Assisted Qualitative Data Analysis Software (CAQDAS). There are various free CAQDAS, such as AnSWR, RQDA compatible with PC, Mac, Linux, WeftQDA compatible with PC, Linux, Tams Analyzer used for Mac only, QDA Miner Lite working on PC and Mac, the PC-compatible Open Code or the cloud-based Saturate and CAT. Technology-aided analysis lends itself to the possibility of turning the ready data into illustrative and understandable graphs to the audience of the research if it is to be presented somewhere, thus enhancing the communicative approach of the work done.

b) Correlational research

Correlational research design introduces a new perspective into research in that it describes predictive relationships, taking research one step ahead of descriptive research, which is bound to describe only, but not establish, a prediction of associations. The method to describe the degree of association between two variables is to calculate the direction and strength of the correlation coefficient, which takes place in the data analysis stage of the process. We may use the correlation coefficient to explain (*explanatory correlational study*), predict (*predictive correlational study*) or establish the high likelihood of a causal relationship between two variables (Dancey & Reidy, 2007). It is important to be aware that correlation does not mean causation. Based on correlation we cannot proclaim that one of the variables (two things, events) is a cause and the other effect. When two variables are correlated, it simply means that as one variable changes, so does the other. A correlation coefficient is a single number (from -1 to +1) that describes the strength and direction of the relationship between the given variables. The positive or negative sign of the correlation coefficient indicates the direction of the relationship between the variables. The *positive sign* means that the variables move in the same direction (both increase or decrease in the same time, that is if one variable increases so does the other, and conversely, when one variable decreases so does the other). The *negative sign* means that the variables move in opposite directions (a decrease in one variable is associated with an increase in the other and vice versa). The closer the number is to 1 (be it negative or positive), the more strongly related the variables are, and the more predictable changes in one variable will be as the other variable changes. The closer the number is to zero, the weaker the relationship and the less predictable the relationship between the variables becomes. In general, a correlation coefficient of 0.9 indicates very strong relationship, 0.6 moderate and 0.3 weak correlation (Dancey & Reidy, 2007).

c) Causal-comparative research

Researchers may wish to establish relationships between two or more groups of people in the past and the present wanting to identify why things may have turned out the way they did (Kravitz, 2020). Causal-comparative research suits this goal and does so very rightly in educational research as it may shed light on causes of desirable as well as undesirable educational phenomena (grades, achievement, levels of understanding) thus helping future learners to learn more and learn it better.

When experimental research is not feasible, the above two types of research are the second-best choice to study the behavioural and educational choices of present or past learners.

3.2 Experimental research design

Experimental studies, typically referred to as *intervention research* (Dörnyei, 2007) have been around since the 1900s (Hsieh et al., 2005). However, with the advent of structural equation modelling, or SEM for short, we have seen a steady decline in carrying out experiments through the course of the last century. Even though SEM, according to Dörnyei, is a powerful tool to analyse correlations and establish causal relationships thanks its ability to combine several variables into one model, some researchers still consider experimental designs as the most founded method of arriving at generalizable causal conclusions regarding educational research.

Experimental designs begin with a specific interpretation and then determine whether it is congruent with externally driven data. In order to do that we set off our research with the hypothesis and test it on experimental and control groups using dependent and independent variables, the former showing us the computable and measurable results of our manipulation of the latter. The main idea behind experiments is that since we carry them out in tightly controlled en-

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vironments, we have full control over all (or rather most) of the variables, and by selecting to manipulate one (in case of single-variable designs) or more than one of them (rendering them factorial designs), while the rest of the variables remains constant, we may conclude with certainty that they affect some variable(s) we are measuring in the same environment (Mertler, 2018; Johnson & Christensen, 2004). And, since we have control for many extraneous factor, experimental studies are the most conclusive of all research designs.

The four main types of experimental design according Mertler (2018) are:

a) pre-experimental design,
b) quasi-experimental design,
c) true experimental design and
d) single-subject design.

Sampling strategies are an essential part of the first three types of experimental design. We may select members of the groups we want to include in our research either randomly or on purpose. Thereby we differentiate two methods, namely the *probability samples* and *non-probability samples* (Fink, 2013). However, even if the probability sample is used, there can occur various distorsions in the carried out research. These distorsions are related to variances between the target population and survey population (probability or non-probability sample), and they value is expressed by means of so-called *sampling error*. According to Bryman (2012), there are four kinds of sampling errors. Basic *sampling errors* are caused by the fact that the survey population (probability or non-probability sample) does not match completely the features of the whole target population. *Sampling related errors* have connection with data collection quality. *Data-collection errors* have connection with the used research tool quality, and finally *data-processing errors* represent errors occurring during the data processing. Based on the sampling error a *confidence interval* can derived to determine range of the studied parameters with the given confidence (on the relevant *level of the significance*; Hendl, 2015).

The generalizability is closely related to the representativeness, and size of the research sample determines generalizability of the research results, i.e. they determine whether and to which certainty the research results can be generalized being valid (Soukup, 2013; Soukup & Kočvarová, 2016).

a) Pre-experimental design

Pre-experimental designs involve either one group, on which an experiment is carried and which is post-tested – being called a *one-shot case study*, or pre-tested and post-tested – being called a *one-group pretest-posttest design*, or two groups being post-tested after one of them has been exposed to some sort of change – *static-group comparison design*. Since a "pretest may sensitize participants to the focus of the experiment" (Rogers & Révész, 2020), its lack in the research process might serve just right when starting investigating a problem.

b) Quasi-experimental design

The basic difference between *quasi-experimental design* and *true experimental design* lies in the presence of random assignment to the experimental and the control group (true experiment) or the lack of it (quasi-experiment). Kirk (2009), Plonsky (2019), Rogers and Révész, (2020) cordially support randomized assignment in that it may do away with inherent differences among groups, making the research internally more valid.

However, according to Shadish et al. (2008) if well-designed, both aforementioned types of design produce comparable results even from the aspect of internal or external reliability. This conclusion is very important for the purposes of carrying educational research as the members of research, the students themselves, form pre-determined clusters, already being allocated to certain schools and classes, which is on many an occasion impossible to be manipulated with. Dörnyei (2007) and Mertler (2018) agree with Kerlinger (1973), who refers to quasi-experimental design as a "compromise design" in it being suitable for field study in a school environment.

Mertler identifies the four main types of quasi-experimental design as follows:

- matching posttest only control group,
- matching pretest-posttest control group,
- counterbalanced design and
- time series design.

Matching posttest only control group

If the random assignment to the experimental and control groups is not plausible, when carrying out a quasi-experiment we strive to equate the two groups as much as possible by matching them on certain variables. This statement is true for the first three above-mentioned design types. The advantage of using a matching posttest only control group design might be the fact that since there is no pretest before the experiment, just like in the case of static-group design, the participants are not influenced by and have no way of gauging what kind of experiment they

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will take part in, thus contributing to the reliability of the post-test and the internal validity of the research as such.

Matching pretest-posttest control group

In the matching pretest-posttest control group design group members are equated based on their pre-test results.

Counterbalanced design

Cohen et al. (2018) introduce the idea of *non-equivalent groups* to cover for situations in which matching is not possible. Such a problem can be taken care of by the random assignments of experimental and control treatments to both groups. Counterbalanced design does just that – equates unmatched group members via a mixed-order treatment design of both groups. In a way, it is similar to *Latin-square design*, which is based on treating all the participating groups with a varying order of tasks to control for test- and task-order effects.

Time series design

The time series design excludes a comparison group and instead uses multiple pre- and post-tests to establish internal validity and show a trend. This design, as we can see it in its name, takes time to do. Therefore, the number of participants in it must be inherently smaller as they must last the whole length of the research, rendering external validity fragile. The reason why we may opt for time series design is to see whether the treatment applied stands the test of time or fades away. Rogers and Révész (2020) note that there is another type of quasi-experimental design not incorporating a control group, in that being similar to time series design. This type of research is called the *repeated-measures design* in which the experimental group undergoes multiple treatments and is measured after each of them.

c) True experimental design

True experimental design is experimental design conducted under lab conditions, a thorough overview of which has been provided by Campbell and Stanley (1963).

True experimental designs share the following attributes: there is one or more than one control and experimental group to which students have been randomly allocated and paired up based on their pre-test results and which undergo one or more than one treatment in isolation the result of which is post-tested. Throughout the process, group members, the minimum number of which according to Mertler (2018) should not be below 30, must not influence each other in any way. We hereby mention examples of it including but not limited to the ones to be found in Mertler: posttest-only control group design, *pretest-posttest control group design*, and the *Solomon four-group design* (also named as *two control groups* and *one experimental group pre-test-post-test design*). In the first case, the pretest is missing but an advantage is that the participants are randomly assigned to their respective groups. Dörnyei identifies the pretest-posttest control group design as a compelling method by many researcher as it has established controls for many threats to internal validity. The Solomon design works with 4 groups, 2 being pretested and 2 not to prove that the results of both experimental groups are down to the experiment and not the effect of the pretest.

Inferential statistics
While in *descriptive statistics* there is no uncertainty, as the descriptive statistics parameters summarize the characteristics of a collected research data set (distribution – frequency of each of the collected values, central tendency – means of the collected values, variability – how spread out the collected values are), *inferential statistics* helps to come to conclusions and make predictions based on the gathered data. It helps to suggest explanations of the observed phenomenon or situation, and allows to draw conclusions based on extrapolations and make reasonable guesstimate about the larger population. In this way inferential statistics fundamentally differs from descriptive statistics that merely summarize the data that has actually been measured. Inferential statistics is used mainly when we compare two or more groups (based on the sets of research data obtained separately for each of these groups). But at this point it needs to be emphasized that inferential statistics usually only suggest and cannot absolutely prove an explanation or cause-and-effect relationship (inferential comes from the verb *to infer*, which means to conclude or judge from premises or evidence and not to prove).

There are many types of inferential statistics and each is appropriate for a specific research design and sample characteristics (Glen, 2014). Most inferential statistics are based on the principle that a test-statistic value is calculated on the basis of a particular formula. That value along with the degrees of freedom, a measure related to the sample size, and the rejection criteria are used to determine whether differences exist between the observed groups. The larger the sample size, the more likely a statistic is to indicate that differences exist between the groups (the larger the sample is, the more powerful the statistic is said to be). Most of the major inferential statistics come from a general family of statistical models known as the *General Linear Model*. This includes e.g. the t-test, Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA), chi-square test, Mann-Whitney and Wilcoxon tests, Kruskal-Wallis and Friedman tests, and many of the multivariate methods like factor analysis, multidimensional scaling, cluster analysis, discriminant function analysis, and so on. To decide which test suits to the particular research, one has to consider whether the data meets conditions necessary for parametric tests, number of samples, and levels of measurement of the variables. However, the most commonly used procedure to compare two (or more) groups is the t-test.

The *t-test* is used to discover whether there are statistically significant differences between the means of two groups, using parametric data drawn from random samples with a normal distribution. Two types of it may be differentiated, the more widespread *independent-samples* and the less popular *paired-samples t-test* depending on whether we are working with data obtained from two different groups or the same group measured on two occasions (ibid.). After gaining the results using SPSS computations, which assume the two-tailed version of it, this test helps us to determine whether the null hypothesis will be accepted or rejected (Tsokalidou, 1995). The good news, as Cohen et al. (2018) state, is that both results mean a "win-win situation" for the researcher, as significant conclusions may be drawn from both of them.

d) Single-subject design

The *single-subject design* is the ideal choice of researchers when they want to focus on individuals rather than groups. The reason for it might be that some outstanding students may emit certain unusual traits, and therefore may not even have a pair in the school they attend. We may attempt to test the effectiveness of corrective treatment to bring about a bettering of the behaviour of such individuals, and for this specific ethical reason some designs may not be suitable, like the *A-B-A design*, which is based on removing the treatment in the final stage to test effectivity. Thankfully, we have other designs to choose from, such as the simplest *A-B design*, or the most popular *A-B-A-B format* to gauge the results of treatment over a longer period of time. A similar but not identical design is the *alternating-treatment design,* which compares two types of treatment on the same person (Dörnyei, 2007). If we manage to get two or three participants in our project, we may measure the effect of a treatment by applying it to only one of them. Such a design is called a *multiple-baseline design*.

4 Conclusion

Quantitative research methods remain to be a powerful tool in educational research because they produce quantifiable, unbiased results of research findings, thus helping educators to understand and accept their truthful nature. This is the starting point for theory to be applied in practice. If educators can open up to new possibilities because they are persuaded that the application of new findings will breed better results, they will sooner or later do so. Hence, the results of theoretical research will transfer into practice, changing the lives of our children thanks to the more advanced level of education they will receive. And that is why educational research must never stop but should be, actually, encouraged to be carried out in every stage of education.

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