IADMS International Association for Dance Medicine & Science

RESOURCE PAPER FOR DANCERS AND TEACHERS

Engaging in Rigorous Quantitative Research

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INTRODUCTION

Dancers are innately curious and passionate humans, and as scientific research has entered the worlds of art and sports, dance science research is on the rise. However, if you could read all of the articles that are written and submitted to journals for publication, you would realize that most of them have several sound aspects, but may fall short due to flaws at some point in the process. Several stages exist in engaging in rigorous research: establishing your research question, designing your study, obtaining ethics approval, developing the methodology, analyzing or describing your findings, summarizing your results, and creating a final discussion. The best research projects include a team of collaborators working together to answer a question about dance.

There are two main areas of rigorous research, called quantitative and qualitative research. **Quantitative research** is the systematic investigation of phenomena using statistical, mathematical, or computational techniques. It is verifiable by means of observation or experiment. Many types of quantitative research exist, but this paper will focus on broad, general characteristics of quantitative research. **Qualitative research**, better known in dance education, anthropology, psychology, and sociology, is descriptive and interpretive. While quantitative research tends to focus on analysis, qualitative research attempts to understand the meaning of the experience to the participants, and it is often conducted in a real-life setting rather than a laboratory. The purpose of this resource paper is to provide general step-by-step guidelines to assist researchers in producing the best possible outcome from a research project, based on quantitative methodology.

ESTABLISHING YOUR RESEARCH QUESTION

Most people who engage in research are excited and curious about various aspects of their chosen field. Before deciding to start a research project, consider whether or not this information will add to the body of knowledge.

The first step in that determination is a thorough review of the existing literature. Journals that may be of use are the *Journal of Dance Medicine & Science, Medical Problems of Performing Artists*, and search engines such as Web of Science, PubMed, and Google Scholar. The next step is to ask whether or not this information will matter, that is, make a useful contribution to the field. For example, looking at dancers' flexibility in relation to core support would be valuable information, but attempting to correlate eye color with professional success is questionable. Finally, and importantly, is this question testable and quantifiable, that is, do the tools exist to collect the information? Decades ago, certain research questions could not be answered, but the advent of kinematics and electromyography has made this research possible. Also is the question specific? Questions such as "Did the dancers get better?" are too vague and unanswerable.

Three terms that are used frequently are question, hypothesis, and purpose. Suppose the study will look at the height of *grand battement* at the barre and in the center (See Figure 1). The question would be stated, "Do dancers perform higher *grand battement* at the barre or in center work?" The hypothesis would be stated, "Dancers perform higher *grand battement* at the barre than in center work." (The null hypothesis in this case would be, "There will be no height difference in *grand battement* at barre and in center work.") At the end of the introduction to your paper, the purpose would be stated, "The purpose of this study is to determine if dancers perform higher *grand battement* when working at the barre or during center work."

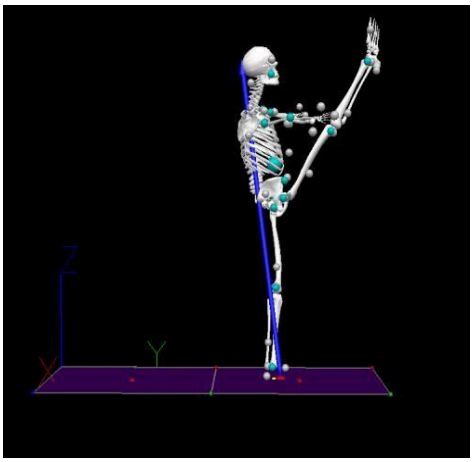

Figure 1: *Dancer doing grand battement devant shown in live time and in the computer image.*

DESIGNING YOUR STUDY

There are many types of studies, but the three seen most frequently are surveys, cross-sectional studies, and longitudinal studies. **Surveys** are the most common descriptive research method, and there are four types, the two most common being the questionnaire and the interview.

Questionnaires and interviews are basically the same, except that the first is done in written form and the second is done by oral questions. A questionnaire must be checked for validity, meaning that it has been tested to make sure the questions are clear and non-leading, and reliability, meaning that if the questionnaire is repeated with the same subjects, they will give the same responses. It is not simply a matter of writing out a list of questions. If you do not know how to validate a questionnaire, seek assistance. Two sources for checking validity and reliability of a questionnaire are:

https://select-statistics.co.uk/blog/assessing-questionnaire-reliability/

https://opentextbc.ca/researchmethods/chapter/reliability-and-validity-of-measurement/

A **cross-sectional study**, sometimes called a snap-shot study, collects data from dancers in a single occasion, called the data collection. In the example above, dancers would come to the lab one time, and be tested doing a series of *battement* at the barre and center. A **longitudinal study** collects data at given intervals over a period of time. The researcher must carefully consider the issue of time frame in designing a longitudinal study, as results might be affected if the duration is too short. A longitudinal study can be observational, such as collecting the *battement* data at the start of the training season, in the middle, and at the end. It can also include an intervention, sometimes called experimental/intervention studies. In this case, you would collect data, do an intervention such as a conditioning program, and collect the data again. This process could be repeated. Your research question will determine which type of study should be used. Note that for many studies, a control group is needed. With intervention studies, a control group will let you know if the changes you are observing are due to your intervention, other factors such as ongoing training, or simply the passage of time.

The next step in designing the study is determining who your subjects will be. Factors such as age, sex, and background will depend on the research question. For example, in the *battement* study, you would want to use dancers with sufficient training to have control in center work. You will also want to do a power analysis to select your number of subjects. A power analysis lets you know how many participants you will need to achieve statistical significance. In general, the smaller the sample size, the larger any difference between group scores will have to be in order to achieve statistical significance. If you wish to do a power analysis, this site will provide you with a download that can perform this calculation: http://www.gpower.hhu.de/

Your research question will also demand certain measurement tools. For example, in the *battement* study the best tool to date would be kinematics, using reflective markers and computers. This system will yield accurate numbers to measure height differences. Taking pictures and using tape measures would be less accurate and might end with misleading conclusions.

At this stage you can select and if needed, train your research team. The people assisting you should be knowledgeable in the data collection methods. Placements of electrodes, reflective markers, skinfold calipers, and other measurement devices demand highly accurate positioning on the body. Inter-rater reliability means that if you are using more than one person to do this work, there will be little difference (or error) between how your team does the placements. In a longitudinal study, even if only one person is doing

this work, that person will need to repeat the accuracy of placement each time, known as intra-rater reliability. For interview research, the people asking the questions must be trained in maintaining neutrality and in knowing when to inquire further if a participant is confused.
At this stage, if you are working with a research team, the author order should be decided and agreed upon. It is generally simple to know who the first author is, the principal investigator. After that, researchers need to agree on the order of second, third, etc. authors depending on workload. While every author may not be involved in every aspect of the project, each one should understand the full project and be able to speak to the process, results, and implications.

Perhaps one of the most difficult tasks is deciding on statistical tests or analysis, which must be done before data collection begins. This includes any ad hoc tests that will be used and selecting the alpha level for results. More will be discussed about statistics in later portions of this resource paper.

Be advised that if you intend to seek funding for your project, it must happen in the planning stages prior to seeking formal approval to continue the study.

OBTAINING ETHICS APPROVAL

All studies need to undergo review by an outside formal body whose charge is to determine that ethical standards are being met. These bodies are called ethics approval committees, Institutional Review Boards, or Human Rights Review Boards. All research universities have these boards, and there are also private companies that provide this service. Many people think that studies involving questionnaires and interviews do not need ethics review, but this is a false assumption. Even participating in a survey can have impact on a participant's life and state of mind, and care must be taken. With simpler research designs, such boards can do expedited approval, but they still must be involved. Note that the ethics board must evaluate the consent form that you will give to all participants. Make sure that your approval is complete before you begin any data collection.

DEVELOPING YOUR METHODOLOGY

Your next step will be to gather your participants. Ideally you want to have a random sample of a given population. In the *battement* example, it would be optimal to have dancers from various dance companies or schools in several cities. However, this is rarely possible. A convenience sample gathers participants from a more discrete population, i.e., a single company or school or university.

Many studies are greatly improved by having a control group, and for some it is essential. For example, if the study is asking the question, are dancers more flexible than non-dancers, you would need non-dancers to make the comparison. Control groups are necessary for intervention studies. In the *battement* case, suppose you wanted to see if a particular balancing program would reduce the height difference in *battement* at the barre and center. You could measure your dancers before and after the intervention. However, without dancer controls you would not know in eight weeks if the reduction in height difference was due to your intervention or simply due to eight weeks of dance classes. The controls give you that foundation/comparison.

Before any data collection occurs on a participant, it is crucial to get written informed consent. Most universities and research centers provide templates of these forms. Note that all consent forms let the participant know certain basic rights. They must be informed about what the research will involve, assured that their confidentiality will be protected, and that they have the right to quit at any time. Also, they will have a phone number to call if they feel they have not been treated properly. Finally, if minors are involved, the parent must give informed consent, and the child will give informed assent.

Your next step is data collection. You already know that you have chosen valid and reliable tests. If your study includes teaching material as part of the data collection, then every attempt should be made to reduce bias in the process. For example, you cannot have one teacher showing material who demonstrates frequently, and another who gives mostly verbal instructions. Make sure that you store your data in a safe, confidential place, and that it is always backed up.

ANALYZING THE FINDINGS

For many researchers, this is probably the stage where professional assistance may be necessary. Even for experienced researchers who have studied statistics, they can encounter study designs that require a high level of sophistication in the analysis. You must decide if you will need help with your statistics, and if so, it is best to bring that person into the process during the design phase.

The first step in the analysis process is to determine if you have a normal distribution. If you do not know what that is, you need a statistician. If your distribution is not normal, then you may need to change the statistical tests you were planning on using. The next step is to enter your data into the appropriate statistics program. Then comes the fun of looking at your results. Remember this important rule: NO FISHING! You must decide ahead of time what your research question is, and what you are seeking. It is not acceptable to look at your results and then decide what your study was about, or to keep trying different statistical applications until something significant appears.

SUMMARIZING THE RESULTS

Assuming you will prepare a paper for publication, you will have the following sections: Introduction (including the literature review), Methods (describing participants and data collection process), Analysis, Results, Discussion and Conclusions. When summarizing the results, only state the statistical results as they relate to your research question. This is not the place for going off on tangents, or for talking about what you think these results mean. Report your statistics in p values. If the computer printout shows p = .000000, state this as $p < .001$. Writing p = .000000 suggests that you did not actually do any testing! This section is often the best place for tables and graphical illustrations, but make sure that you refer to them in your text.

Three other common statistical terms that you will need to include are the mean, the standard deviation, and the standard error. The mean is simply the average. Note that the mean by itself is insufficient information. The mean of the series 3,3,4,4,5,5 is 4. However, the mean of 1,2,2,3,5,5,6,8 is also 4. As you can see, the mean of both series is 4, but one group is quite similar and the other has more variation. The standard deviation (SD) tells you how much the values vary from one another. The standard error (SE) quantifies how precisely you know the true mean of the series. It takes into account both the value of the SD and the sample size. If you do not understand all of these terms thoroughly, you need to seek the assistance of a statistician.

CREATING A FINAL DISCUSSION

Here is the place to talk about what your results mean. Be cautious about generalizing when it is not appropriate. If your participants were 10 year-old boys, do not state that your results are true for all adolescents. If your participants only study ballet, do not generalize to all dancers. Stating the limitations of your study is not admitting weakness. It is simply acknowledging what you were able to do, given circumstances and participants. In the *battement* study, if all of your participants were female, then you need to state that not having males is a limitation. It is also imperative to provide recommendations for future study. This might be expanding the number or type of participants, suggesting longer training in an intervention study, or using different measurement tools.

Research can appear daunting, and some of the obstacles can seem insurmountable. However, if you go about your research in clear steps, and avoid some of the common pitfalls, you will find research to be a rewarding and tenure-producing experience.

ILLUSTRATION CREDITS

Figure 1 images from the dissertation of Donna Krasnow, taken in the biomechanics lab at California State University, Northridge, California

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