Original Articles

HOW TO SET UP, CONDUCT AND REPORT A SCIENTIFIC STUDY

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ABSTRACT

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This continuing education paper gives some guidelines on how to write a scientific paper. A good paper begins with a high quality experiment! Therefore, based on an idea, authors should first inform themselves by reading the literature, refine their idea and convert it into a scientific question. This is all laid down in the first draft of the "**Introduction**" of the future paper.
The authors must seek for ways to answer the scientific question stated above, which is done by describing it in detail in the "**Material & Methods**" section of the paper. This may require a pilot study. Once the experimental design, the parameters to be measured and the materials involved are known, it is good practice to consult a statistician in order to determine the statistical method to be used for analyzing the results.
The execution phase is dominated by meticulously applying the methods described above and documenting everything in detail. Once results are obtained, they should be first displayed in a descriptive manner to determine the final quantitative analysis, which leads to tables and figures showing the significant differences.
What is left at this point is to write a "**Discussion**", which should be well structured and then to compile the whole manuscript in the format required by the journal of choice to submit to.
Finally some hints are given how to successfully deal with reviewers.
Conclusion: Following the recommendations given, the probability to obtain acceptance of a paper may be quite good.
Keywords: experimental design, scientific writing, publishing.

1. Introduction

Performing a scientific study is basically the same as running a project. Therefore all rules regarding project management apply to scientific studies as well. Most projects, especially larger and more complex ones are run by teams. In teams the individual players which are unified to achieve the same common objective (successful completion of the given task) give up some of their individuality and at the same time bring in their competence. To guarantee the well functioning of the team, each member should comply to commonly defined rules. Most of these rules govern compliance and communication. For me the most basic rule is the following: "I say what I think and I do what I say". In scientific projects usually a multitude of players are involved, especially in a teaching institution. Researchers interact with other researchers, with students, lab technicians, statisticians, administrators, and industrial partners or grant administrators etc. Therefore, to be successful, open and straightforward communication is indispensable as well as the establishment of a framework in which the team is able to perform.

An analysis of successful and failed projects reveals several general patterns[1] (Fig 1).
A plot of resources spent versus times revealed that most of the effort in successful projects is spent at the beginning of the process.[1]
This means that the information is properly collected, the objectives are well defined, everything has been thought through as well as possible based on the actual knowledge and the task ahead is well defined. Then the "machine" can be started and the project runs as perceived in the creative phase. During the execution phase usually the effort diminishes and the preplanned tasks can be accomplished without surprises. In product development I have learned that following a well thought and structured scaffold is a good strategy for success. On the other hand, projects that have failed show a pattern that is quite different. With a brilliant idea the project is just started with the anticipation that it will work. So the start is nice, because without too much effort the project is moving forward, usually with lots of enthusiasm. However, when the project is usually on its way, unanticipated problems arise that require more

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Figure 1. Effort time plot of successful (green) and failed (red) projects.

input in effort and resources. Due to the lack of knowledge or good strategy, this process is usually repeated multiple times with increasing effort and resources to be consumed (with budget amendments), until a point is reached, where the success point has moved into the distant future and the required resources cannot be estimated anymore. This is usually the moment where there is a danger that the management or the team involved may decide to abort the project.

Before anyone engages into a scientific study, the reasons and objective should be clearly stated. There are many reasons that motivate people to conduct research, such as:

- obtain a title
- obtain/maintain a position
- apply for grant money
- become rich
- know more
- target an academic career
- change the world!

It is important to be personally very clear about the objectives, since sooner or later the task will become tougher and this may require extra efforts. This means that more motivation is required to continue the research project.[2] It requires more than motivation to stimulate the researcher to spend night after night above the microscope while other team members, not involved in the research, may go partying to have a good time in the local bars.

Once you are clear with yourself about the task at hand to run your research project the next step is very important. The question why to publish must have been deeply understood by the researchers. A research project is only completed, once it is published. Why? If the outcome of an experiment is not published, no one will ever know it. "L'art pour l'art" is the most stupid thing I have ever seen – it is a waste of time and effort. Let other people know what you have found and hopefully your activity will improve the way we treat our patients.

However publishing is not equal publishing. If you have a question, the modern way to approach it is to search the internet. If the question means to find a publication, then there are powerful data bases such as pubmed or google scholar, which can guide you quickly to a high number of references. If you just search the internet (e.g. google.com) the yield is much better. However there is no way to validate and verify the information.[3] This becomes obvious, when you search a topic that you know yourself well. There comes the peer review process, which will be discussed later. This is a mechanism, which, if well done, should lead to a better report, enhanced in several of its categories, as contributed to by those performing the review. While many of the statements made remain the responsibility of the author, there is the expectation that the review paper guarantees that it is correct and does not contain methodological errors or biases. Andreas Lindhe, the Editor of the Scandinavian Journal of Dental Research has once stated in a continuing education: "Nothing is scientifically "shown" or "proven" before it has been published in a SCIENTIFIC journal subject to peer review, so one can critically judge WHAT has been done, HOW it has been done and evaluate HOW SOLID it is!".[3] This is very true, but only if the peer review was performed well.[3] Unfortunately in the last 10-15 years more and more so called open access journals have been created pursuing the idea that knowledge should be publicly available for free – in itself a very noble idea.[4,5] Publishing is a big business, and targeting profit has undermined the solidity of the peer review process.[6]

One experiment had shown this quite clearly. A researcher had constructed a scheme which he modified in order to create 304 fake studies which had built in several faults, and it was expected that a reviewer should have detected this. Then the researcher invented author names and universities and departments in cities placed mainly in the upcoming world. These manuscripts were submitted at a rate of 10/week to open access journals, with the result that 157 manuscripts (52%) were accepted, and only 98 manuscripts were rejected (32%).[7]

In dentistry and medicine the information should be, if possible, evidence based, which makes a lot of sense. Clinicians treat patients and the quality of the treatment should be based on clinical studies. This has generated the evidence based approach[8,9] and a hierarchy of the quality of evidence putting expert opinion at the bottom and systematic reviews of prospective randomized double blinded clinical studies on the top[10,11] (Fig. 2). Unfortunately there are errors and dangers of bias clearly present here as well.[12,13]

An infrastructure is needed to perform research. Researchers need a laboratory, access to a clinic or a dental office as well as access to regulatory institutions (e.g. institutional review board), and to literature. As described above, the first step is a literature search done via internet. However it is highly recommended to complement this with a manual search, which requires access to a good library.

Finally for young researchers having a mentor is essential and for the researcher this should be beneficial. It is a good idea to check out potential mentors, which should be competent in the field of the potential research. It is important to know if the mentor has enough time to deal and consult the mentee. A good mentor should always be accessible and available to read every document/draft submitted within a rather short time (better days than months) and return feedback with

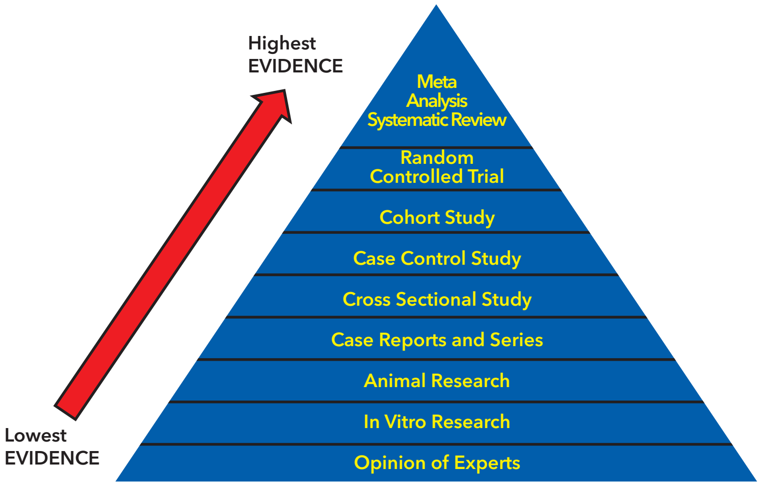

Figure 2. Pyramid of Evidence.

detailed comments. It would be beneficial for the mentee, if the mentor could provide guidelines, instructions for use and templates. On the other side the mentee cannot expect from the mentor that he/she would do the work. All he/she can do is to consult, open doors and provide connections. As a mentor I like it very much, when the mentee comes up with his/her own idea for a project.

2. Structure of a scientific paper

A scientific paper always has the same structure:[2] After the title with the authors and their affiliations and contributions usually the paper should start with an "Abstract". The body of the paper is opened with an "Introduction", followed by "Materials & Methods". Then a chapter "Results" should be followed by a "Discussion" and "Conclusions". Finally a "Literature" list should complete the paper. This basic framework can be modified depending on the type of publication. In a thesis the introduction serves more than introducing the reader into the topic. The other purpose is that the author must demonstrate his/her competence in the field. Therefore the "Introduction" includes usually an extensive literature review, that may be structured as a subchapter. Also "Materials & Methods" is usually more detailed than in a paper published in a scientific journal. If a thesis deals with multiple experiments it is highly recommended to treat every experiment like a single publication and use a general "Introduction" at the beginning and an allover "Discussion" with conclusions at the end as a big clasp to keep the whole project together.
Finally Industrial Reports have slightly different objectives. Usually the manufacturer wants an answer to a specific question, such as the in vitro wear rate of a material and/or the failure rate and reasons after a specific clinical service time. The "Introduction" of an Industrial Report can be very brief, because one must be assured that the financing partner has done its homework before agreeing to spend money on a study. On the other hand, the chapter "Materials & Methods" cannot be detailed enough. This is important to realize, because if poor results occur it is important to know exactly what has been done. This is the only way to improve the material or the procedure.

3. Creative phase

The creative phase is usually the most thrilling part but usually the most difficult as well. It starts with an idea, which most of the time is quite vague. Therefore the first step is to write it down as precisely and clearly as possible. "An idea that cannot be put on paper is not a good idea".[1]
The next step is to collect information about this idea. See if someone else had exactly that idea or a similar idea. Determine what is really new with the idea and where from the idea can be developed further. The answers to these questions lie somewhere in the world literature. Therefore a literature search is unavoidable. The literature found should flow into the personal data bank of the researcher. Modern computer programs like Endnote are very helpful, because they allow easy insertion of literature quotes into a manuscript. Usually such a search starts on the internet and may yield much more papers that one can read. Therefore the search strategy may be refined, which usually parallels refinement of the idea. Once an overseeable number of papers has been found, the articles must be checked whether they are within the scope of the idea, which is usually done by reading the abstracts. The ones that were positively selected should be read. Most information can be extracted from the chapters "Materials & Methods" as well as from the "Result" section. However reading the "Introduction" may reveal more information about the topic of interest and the "Discussion" may contain helpful thoughts to refine the own question. If the search has found review papers it is a very good start. The next step is a manual search by scanning through the literature lists at the end of the read papers. This may reveal more useful sources. Some of them may not be available on the internet, which requires the physical presence of the researcher in a good scientific library.

The above mentioned search of the literature has two functions: one to acquire information and two, to trigger the brain to think more about the original idea. This is the moment to start with writing the Introduction of the planned scientific study. A good way to organize the thinking process is to generate a "mind map" which is a graphical display with textboxes, key words or symbols with lines and arrows that symbolize connections (Fig. 3).

This mind map should be the backbone or skeleton of the Introduction since it helps to fulfill the task of informing the reader that never has the idea of the planned study been approached before, about what it is. Beginning very wide and narrowing it down towards more and more specific contents is focusing more and more towards the own project. By definition the last sentence of the Introduction should start with the words: "The objective of the present study is….". Once the researcher has reached that point usually the originally vague idea has become crystal clear and even more has morphed into a precise scientific question. This question should be the logical consequence of the content of the text above. A very common error is that the research tool used is part of the objective. This may never be the case. First there is the question/problem. Only in the next thought a solution is looked for, which is then described in "Materials & Methods". In experimental papers the formulation of the objective should be followed by a null hypothesis, which later on can be rejected or accepted. An example for a null hypothesis would be: "All tested composites showed equal wear rate".

Writing an introduction means scientific writing which is full of traps, pitfalls and difficulties, especially for a less experienced writer. What is most important is the clarity of the content. Scientific language does not mean complicated language, the contrary is true. The simpler the formulation, the better the understanding. A handicap for most authors of scientific papers is that usually they must be written in English which usually is not their mother tongue. The nomenclature of technical terms must be correct and metric units should be employed[14] (Tab. 1 a-d). Furthermore abbreviations should be explained the first time they are introduced and synonyms should never be used for the same thing. The impersonal form is preferred ("it was done" rather than "I did") and the use of tempora is clearly defined. Everything that was in the past (results from other researchers, things the authors did etc.) is put in the past tense (e.g. Van Meerbeeck et al reported that self etching adhesives yielded a thinner hybrid layer than etch & rinse adhesives) and only things that are generally accepted should be written in the present tense (eg. saliva is a buffer or chloroform is a solvent). Every statement in an introduction must be backed with a literature quote. At this stage it is recommended to put the literature quotes in parentheses with just the author names and

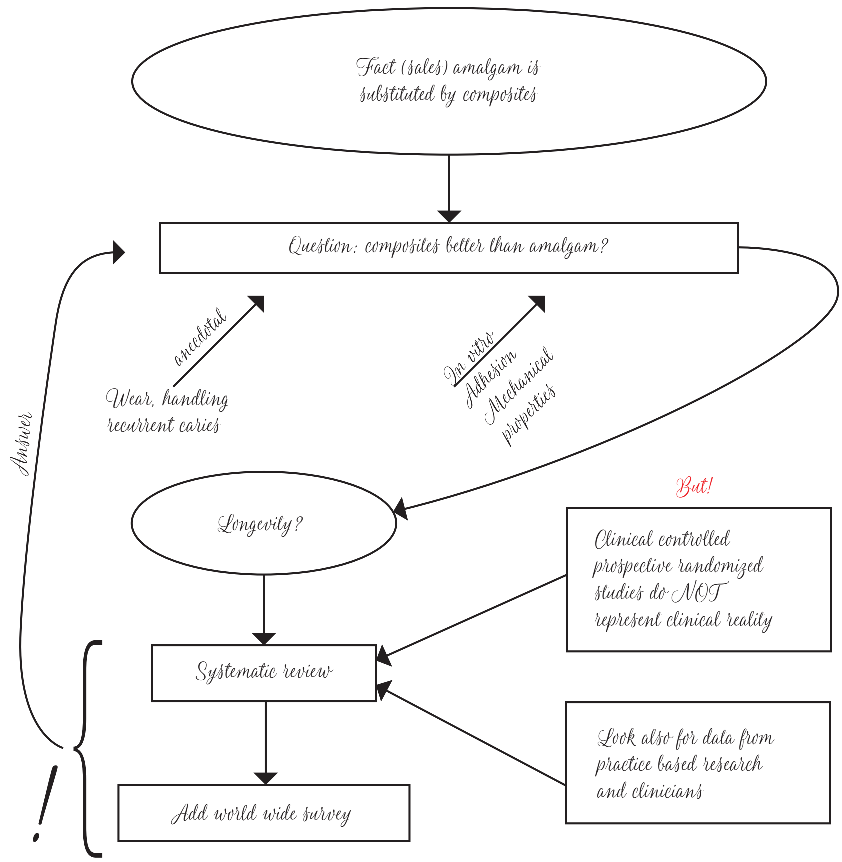

Figure 3. Mind Map. The present format is only for better readability set in the computer. Mind maps are dynamic and should be done by hand on a note pad or a black board. The content of this mindmap is hypothetical, its purpose is to show the principle only.

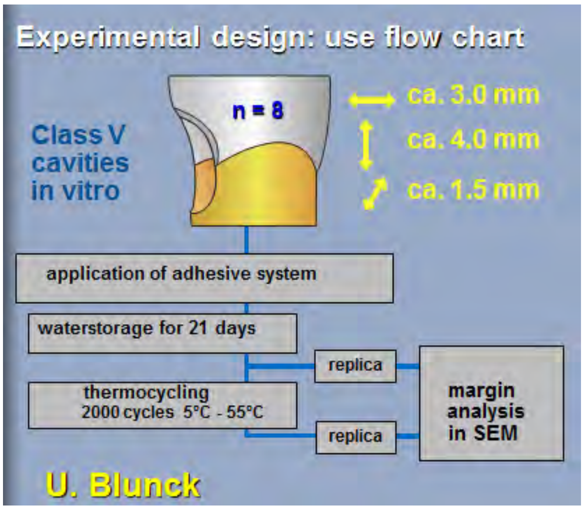

Figure 4a. Graphical display of experimental design (Courtesy of Dr. Uwe Blunck, Berlin).

the year. If the same author has published more than one quoted paper in the same year, then the specific article may be identified with letters: a, b, c, etc.). This leads to the question what should be quoted and listed?

- Earlier work in the area
- Methodology used
- Other publications of importance
- ONLY publications actually used in text!

Common errors are that the literature search has failed to find relevant papers to the topic. Often secondary literature is quoted instead of the original source (e.g. Roulet described the use of Silane in composite formulations in his thesis, referring to Pluddemann et al as the inventers of Silane. An author uses Roulet as a reference for Silane). Another error is quoting a paper for a certain fact that was not described in the quoted paper and finally the quote of opinion instead of experimentally based facts is not correct as well. Today more and more publishers use software to detect plagiarism. This reveals yet another common error: that of the simple use of copy paste to insert text fragments from other articles (even your own!) into your own paper without putting the text in "" and quoting the source. Finally not acknowledging work of your competitors and quoting only your own papers is not an error per se, but a fact that sheds a bad light on your person.

Once the objective is clear, the author must provide a way to solve the problem. This is described in "Materials & Methods". What to do must be described to the smallest detail BEFORE the experimentation begins and once it has been defined it may NOT be changed, because the situation most likely occurs that the results cannot be correlated to the investigated parameters anymore; the change has introduced another variable. This is big trouble.

If a standard method is used, it is sufficient to describe it and to refer to its source. Furthermore it is highly advisable to practice it before it is used for the experiment. If this is ignored, bias is introduced, because the inevitable learning curve is included into the results produced. Very often some new equipment or procedures are used to address a research question and the usefulness is not known. Therefore in these situations usually a pilot study should be performed. It should be dealt with identically to the real experiment, but with a substantially smaller sample size (feasibility study). The outcome of the pilot study may lead to modifications of the "Materials & Methods" of the main study.

The report of a pilot study may either be inserted after the "Introduction" reporting its "Materials & Methods" and "Results", or the pilot study may be just mentioned in the discussion.

Writing "Materials & Methods" usually begins with describing the experimental design. This is the phase where the most intellectual power and creativity enter into play. The experimental design must be set in order to, without any doubt, be able to answer the research question. Therefore it is important to eliminate all known confounders that may cloud your data. (A confounder is a variable that is not measured, but influences the outcome that is measured). Furthermore randomization is

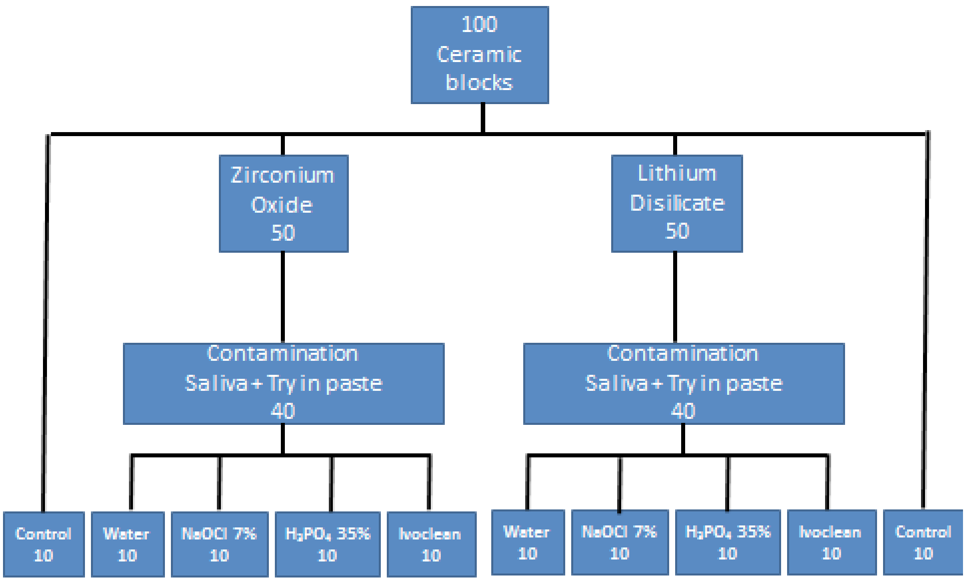

Figure 4b. Graphical display of balanced experimental design.

always a good thing to do, because it may allow for generalization of the results, because the sample used was representative for the population of interest. A figure of the experimental design would be helpful for the reader to understand what was done (Fig. 4a and b). The materials used (incl. composition, manufacturer and lot #) are best summarized in a table. Then the experimental groups must be described in detail including the # of samples. The procedures/group must be described as detailed so in case the author quits, the person that takes over can continue the experiment under identical conditions. This means that ingredients must be described precisely (e.g. concentration with upper and lower limits, times, batch numbers and decision rules, when to accept or reject the outcome of a process). Not only how samples are made and what is done to them (e.g. fatigue test or exposure to any agent or cell cultures etc.) must be described in detail, but also how the outcome is measured.
Also in this phase all legal requirements must be clear and accounted for. This is very important; because some may lead to a not publishable manuscript and may put the author in big trouble (e.g. Editors of most medial journals have agreed not to publish any clinical study that was not registered with www.clinicaltrials.gov). Every experiment involving human subjects or animals is regulated by institutional review boards (IRB) in order to make sure that the declaration of Helsinki is observed.[15] Therefore IRB approval is mandatory before ANY action is started. Working with dangerous bacteria or viruses requires formal training and permission as well as using radioactive materials. Finally the planned statistical analysis must be outlined in the chapter "Materials & Methods". The type of test and the software used should be mentioned. Therefore it is a very good idea to consult a statistician in this phase of the project.

4. Execution phase

Once everything is clear and written down, the experimentation can begin. The written chapter Materials and Methods must be used as an instruction set for the experimentation. Furthermore it would be a good idea to prepare templates for inserting and collating results and having them in the correct format for the statistical evaluation. Such templates can easily be created using excel spread sheets.
During the experimentation, documentation is the most important thing. Samples must be labelled in a way that they cannot be mistaken for another one. Furthermore the identifiers must be physically indestructible. Physical engraving is superior to "permanent" marker, since the latter can be erased by a passage through alcohol! Furthermore what ever is done must be protocolled in written (The GMP (Good manufacturing practices) mantra is: "What is not written down has never happened").[16] Therefore maintaining a record of steps in a scientific diary is highly recommended. If something goes wrong, the only way to decide if the data are still useful, is to exactly know what has been done. It is recommended as well to document redundantly, eg. using more than one of the paper and computer protocols, photos stored in data base and printed etc. Photos should be taken in order to document what was done as well. This will be useful in the reporting phase.
Once data are produced, it is recommended as a first step to test if they are normally distributed.[17] This will determine which statistical tests must be used, as well as which form of graphic display of the data would be most suitable (normal distribution: mean ± SD, not normally distributed: box plots with median and 25^{th} and 75^{th} percentile).[18] To preliminary check the data, it is recommended to display them graphically in order to recognize where there are differences. Then a first statistical analysis should be performed to determine where significant differences are found. This is the moment to decide, if groups should be pooled (remember: this is only correct if there are no significant differences between the pooled groups).
Once the statistical analysis has been finished the outcome should be carefully interpreted. In a balanced design the best possible outcome is to report main effects (e.g. if you looked at sales of wine as a function of the bottle shape and its position on the shelf, a main effect is, if, regardless of the shape, bottles on the top shelf sell the best and regardless of the position cylindrical bottles sell the best as well). In the ANOVA this is reflected by not having significant interactions (Fig. 5). If significant interactions occur, then only comparisons between single cells may be done, which is performed with post hoc tests (Bonferoni, Scheffee or Tukey).[19] Usually the level of significance is set before the analysis e.g. $p<0.05$. If this level is not met the differences observed are NOT significant, this means that the observed differences cannot be accounted for due to the experimental conditions, but are random. Therefore it is not correct to talk about a trend, when the significance level has slightly been missed.

4.1. Reporting phase

Now that results are available it is time to think where to publish. The best chances for acceptance are if the scope of the Journal of choice is congruent with the topic of the paper to be submitted. The first step should be to read the guidelines for authors. Most Journals require that the text is on a separate file and require specific fonts and line spaces (e.g. 1.5). Figures and Tables should be on separate files and there are minimum requirements for the resolution of the figures. Usually Legends are required to be on a separate file as well. A submitted manuscript must comply to a 100% to these guidelines. If it does not follow them meticulously, then the chance of outright rejection before the review process is high. All the recommendations given above to write the "Introduction" and "Materials & Methods" apply of course. There are a few more however. The working title must be now converted into the final title of the publication. Some journals limit the number of words. A title is the first thing a potential reader sees. Therefore it should be appealing and motivate the reader to continue. The title should:

- Be concise, precise
- Adequately represent the contents of the article
- May not promise something it can not deliver
- Must specify animal species/clinical,
in vivo/in vitro, methodology

Key words must be assigned to the paper.
The authors sequence is a topic that often raises

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                          The ANOVA Procedure
Dependent Variable: FLEX
                                                   Sum of
Source               DF         Squares     Mean Square    F Value    Pr > F
Model                 3      278439.288      92813.096        7.55    0.0002
Error                60      737511.323      12291.855
Corrected Total      63     1015950.611

             R-Square      Coeff Var       Root MSE     FLEX Mean
             0.274068       16.03280       110.8686      691.5114

Source               DF         Anova SS     Mean Square    F Value    Pr > F
HEAT                  1        6305.4617       6305.4617       0.51    0.4766
SURFACE               1      249691.7826     249691.7826      20.31    <.0001
HEAT*SURFACE          1       22442.0436      22442.0436       1.83    0.1817
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Figure 5. Analysis of Variance (ANOVA) of flexural strength of Zirconia specimen bars as influenced by surface grinding (surface) and heat treatment (heat). Note that heat has not a significant influence but surface condition has. There are no significant interactions.

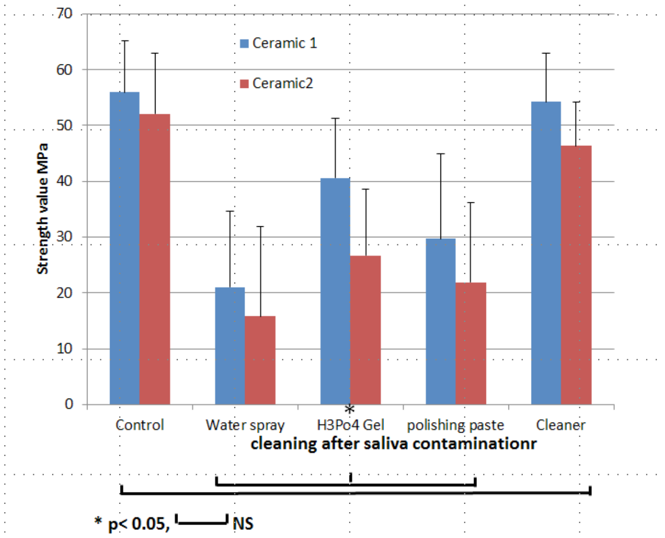

Figure 6a. Example of reporting parametric data as bar graphs with standard deviation. Tensile strength of composite bonded to two ceramics after different cleaning procedures of saliva contaminated ceramics.

conflicts, despite the fact that the rules about who should be where are obvious.[20] Only persons who have contributed to a significant degree scientifically/intellectually to the paper are included in the author line. Other contributions can be accounted for in the Acknowledgements at the end of the paper. Each author should know the article and be able to take on scientific responsibility for it. Who had the most scientific/intellectual input should be the first author. Conflicts may occur in mentor-student situations. My personal view here is that the amount of contribution of the student should determine whether he/she is first author or not. If the idea came from the student, the mentor helped and advised, the student performed the experiment and wrote the manuscript (even with help of the mentor), then it is clear that the student is the first author. On the other hand, if the idea and the experimental design are from the mentor, the student performed the experiment, but the mentor wrote the manuscript, then the mentor should deserve the first place in the author's list. To avoid conflicts more and more journals require disclosure of the contribution of every author.

The next thing to write is the "Abstract". This is a difficult task for many reasons. Very often the journal guidelines restrict its number of words and imply a specific structure. The abstract must summarize in a very condensed form the objective, what was done, how it was done and the results. Usually a conclusion is the final point of an abstract. It is important to include the statistics and hard numbers of the results.

If a reader has been drawn into the paper by the title, then the abstract is the next thing he/she will look at. Therefore it is important that the abstract is well done and informative, because it will then motivate the reader to continue reading. Furthermore abstract, title and keywords are extremely important for the paper to be found in databases, since only these are used to index the paper.[21, 22, 23]

The chapters "Introduction" and "Materials and Methods" are already done, so in the phase of writing the first version of the manuscript, they can be taken with only slight modifications. So the next chapter is "Results". Here the results are displayed in form of tables and figures. Examples are shown in Tab 2, Fig. 6a and b. The text can be short and should mention the outcome of the statistical analysis as

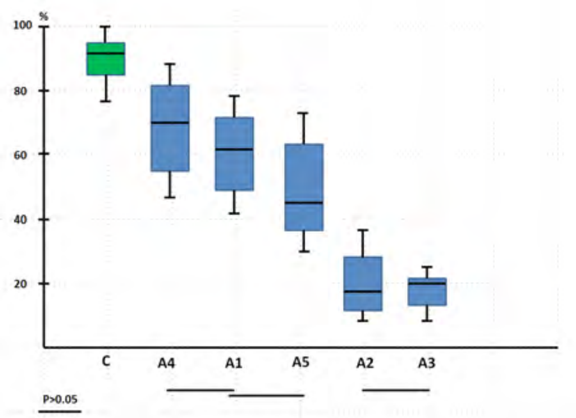

Figure 6b. Example of reporting non parametric data as box plots. Margin quality (% of excellent margin) of six different adhesives (c=control).

well which can be printed as a table. Furthermore the text should point to the reader some specifics of the results and highlight important outcomes. No explanations and interpretations should be given in the chapter "Results". Common errors are that the data are directly copied from the statistical analysis, where the computer calculates as many digits after the dot as instructed thus suggesting a precision which does not reflect the data (5,79438 ± 3,22459 instead of 5,8 ± 3,2). The graphic display of the data should correspond with the type of analysis: bar graphs with mean and SD for results of parametric tests and box-plots for non parametric tests. It is not recommended to use 3D graphics unless there is a need for (displaying the relationship of 3 parameters in one graph). And finally table and graphics must contain information about the statistical analysis, the minimum being the p value and showing where the significant differences are.

The "Discussion" is the only place, where interpretations, explanations and maybe speculations are allowed. Very often discussions are difficult to follow because the reader is not as familiar with the topic as the authors and, on top of it all, there is a lack of structure. It is recommended to discuss first "Materials & Methods": Why were the materials used, why was the used method selected and which are its advantages/disadvantages or limitations. Compare your method with methods of other investigations etc. Only then in a second subchapter must the results be discussed: Here the null hypothesis can be accepted or rejected

Table 1a-d: SI Units (Taylor and Thompson 2008)

Table 1a. SI Base Units.

Base quantity		SI base unit	
Name	Symbol	Name	Symbol
length	*l, x, r,* etc.	meter	m
mass	*m*	kilogram	kg
time, duration	*t*	second	s
electric current	*I, i*	ampere	A
thermodynamic temperature	*T*	kelvin	K
amount of substance	*n*	mole	mol
luminous intensity	I_v	candela	cd

Table 1b. Examples of coherent derived units in the SI expressed in terms of base units.

Derived quantity		SI base unit	
Name	Symbol	Name	Symbol
area	*A*	square meter	m^2
volume	*V*	cubic meter	m^3
speed, velocity	*v*	meter per second	m/s
acceleration	*a*	meter per second squared	m/s^2
wavenumber	σ, $\tilde{\nu}$	reciprocal meter	m^{-1}
density, mass density	ρ	kilogram per cubic meter	kg/m^3
surface density	ρ_A	kilogram per square meter	kg/m^2
specific volume	*v*	cubic meter per kilogram	m^3/kg
current density	*j*	ampere per square meter	A/m^2
magnetic field strength	*H*	ampere per meter	A/m
amount concentration,[a] concentration	*c*	mole per cubic meter	mol/m^3
mass concentration	ρ,γ	kilogram per cubic meter	kg/m^3
luminance	L_V	candela per square meter	cd/m^2
refractive index[b]	*n*	one	1
relative permeability[b]	μ_r	one	1

(a) In the field of clinical chemistry this quantity is also called "substance concentration"
(b) These are dimensionless quantities, or quatities of dimension one, and the symbol "1" for the unit (the number "one") is generally omitted in specifying the values of dimensionless quantities

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Table 1c. Coherent derived units in the SI with special names and symbol.

	SI coherent derived unit[(a)]			
Derived quantity	Name	Symbol	Expressed in terms of other SI units	Expressed in terms of SI base units
plane angle	radian[(b)]	rad	1[(b)]	m/m
solid angle	steradian[(b)]	sr[(c)]	1[(b)]	m^2/m^2
frequency	hertz[(d)]	Hz		s^{-1}
force	newton	N		$m\ kg\ s^{-2}$
pressure, stress	pascal	Pa	N/m2	$m^{-1}\ kg\ s^{-2}$
energy, work, amount of heat	joule	J	Nm	
power, radiant flux	watt	W	J/s	$m^2\ kg\ s^{-3}$
electric charge, amount of electricity	coulomb	C		s A
electric potential diference,[(e)] electromotive force	volt	V	W/A	$m^2\ kg\ s^{-3}\ A^{-1}$
capacitance	farad	F	C/V	$m^{-2}\ kg^{-1}\ s^4\ A^2$
electric rezistance	ohm	Ω	V/A	$m^2\ kg\ s^{-3}\ A^{-2}$
electric conductance	siemens	S	A/V	$m^{-2}\ kg^{-1}\ s^3\ A^2$
magnetic flux	weber	Wb	Vs	$m^2\ kg\ s^{-2}\ A^{-1}$
magnetic flux density	tesla	T	Wb/m^2	$kg\ s^{-2}\ A^{-1}$
inductance	henry	H	Wb/A	$m^2\ kg\ s^{-2}\ A^{-2}$
Celsius temperature	degree Celsius[(f)]	°C		K
luminous flux	lumen	lm	cd sr[(c)]	cd
illuminance	lux	lx	lm/m^2	m^{-2} cd
activity reffered to a radionuclide[(g)]	becquerel[(d)]	Bq		s^{-1}
absorbded dose, specific energy (imparted), kerma	gray	Gy	J/kg	$m^2\ s^{-2}$
dose equivalent, ambient dose equivalent, directional dose equivalent, personal dose equivalent	sievert[(h)]	Sv	J/kg	$m^2\ s^{-2}$
catalytic activity	katal	kat		s^{-1} mol

(a) The SI prefixes may be used with any of the special names and symbols, but when this is done the resulting unit will no longer be coherent.
(b) The radian and steradian are special names for the number one that may be used to convey information about the quantity concerned. In practice the symbols rad and sr are used where appropiate, but the symbol for the derived unit one is generally omitted in specifying the values of dimensionless quantities.
(c) In photometry the name steradian and the symbol sr are usually retained in expressions for units
(d) The hertz is used only for periodic phenomena, and the becquerel is used only for stochastic processes in activity reffered to a radionuclide.
(e) **Editors' note:** Electric potential difference is also called "voltage" in the United States and in many other countries, as well as "electric tension" or simply "tension" in some countires.
(f) The degree Celsius is the special name for the kelvin used to express Celsius temperatures. The degree Celsius and the kelvin are equal in size, so that the numerical value of a temperature difference or temperature interval is the same when expressed in either degrees Celsius or in kelvins.
(g) Activity referred to a radionuclide is sometimes incorrectly called radioactivity.
(h) See CIPM Recommendation 2 (CI-2002), p. 78, on the use of sievert (PV, 2002, 70, 205).

based on the results. Give reasons for the outcome, explain why significant differences were found or not, compare your data with the outcome of other studies and explain why there are differences, if indicated. If possible give explanations about the possible impact to clinical dentistry of the results and finally, it is helpful if indications about further research based on the results of the present study is given. Having said all of the above, one must be careful in the formulation. It should be very clear which are facts from the study or other studies, which are interpretations of these facts and which are hypotheses one could come up based on the findings.

At the end of the "Discussion" conclusions should be drawn. They must be strictly limited to the facts of the findings in the present study and should be formulated as briefly as possible (e.g. "the in vitro wear volume of the glass ionomer tested was more than 2x the wear volume of the universal composite". Avoid bringing in wishful thoughts into the conclusions!

At the very end of the text there is space for "Aknowledgements". Here usually the authors should include data on sponsors, agencies, industry that supported the costs of the studies (if supported by a grant, it's # must be mentioned) and thanks to collaborators that helped to accomplish the task.

Finally under "Literature" all the papers, books and reports that were quoted in the text are listed with their proper source either in the sequence of their first appearance in the text or alphabetically, depending on the instructions for authors of the respective journal.

Once the first version of the manuscript is completed, it should go through language editing, if the authors do not have English as a

Table 1d. Examples of SI coherent derived units whose names and symbols include SI coherent derived units with special names and symbols.

	SI coherent derived unit		
Derived quantity	Name	Symbol	Expressed in terms of SI base units
dynamic viscosity	pascal second	Pa s	m^{-1} kg s^{-1}
moment of force	newton meter	N m	m^2 kg s^{-2}
surface tension	newton per meter	N/m	kg s^{-2}
angular velocity	radian per second	rad/s	m m^{-1} s^{-1} = s^{-1}
angular acceleration	radian per second squared	rad/s^2	m m^{-1} s^{-2} = s^{-2}
heat flux density, irradiance	watt per square meter	W/m^2	kg s^{-3}
heat capacity, entropy	joule per kelvin	J/K	m^2 kg s^{-2} K^{-1}
specific heat capacity, specific entropy	joule per kilogram kelvin	J/(kg K)	m^2 s^{-2} k^{-1}
specific energy	joule per kilogram	J/kg	m^2 s^{-2}
thermal conductivity	watt per meter kelvin	W/(m K)	m kg s^{-3} K^{-1}
energy density	joule per cubic meter	J/m^3	m^{-1} kg s^{-2}
electric field strength	volt per meter	V/m	m kg s^{-3} A^{-1}
electric charge density	culomb per cubic meter	C/m^3	m^{-3} s A
surface charge density	culomb per square meter	C/m^2	m^{-2} s A
electric flux density, electric displacement	culomb per square meter	C/m^2	m^{-2} s A
permittivity	farad per meter	F/m	m^{-3} kg^{-1} s^4 A^2
permeability	henry per meter	H/m	m kg s^{-2} A^{-2}
molar energy	joule per mole	J/mol	m^2 kg s^{-2} mol^{-1}
molar entropy, molar heat capacity	joule per mole kelvin	J/(mol K)	m^2 kg s^{-2} K^{-1} mol^{-1}
exposure (x and γ rays)	coulomb per kilogram	C/kg	kg^{-1} s A
absorbed dose rate	gray per second	Gy/s	m^2 s^{-3}
radiant intensity	watt per steradian	W/sr	m^4 m^{-2} kg s^{-3} = m^2 kg s^{-3}
radiance	watt per square meter steradian	W/(m^2 sr)	m^2 m^{-2} kg s^{-3} = kg s^{-3}
catalytic activity concentration	katal per cubic meter	kat/m^3	m^{-3} s^{-1} mol

mother tongue. It is important to understand that a dental publication uses some specific professional language. Therefore it is not sufficient to find someone proficient in English, the person proofreading must also be knowledgeable on the dental technical language (dentist or dental technician or dental hygienist). So the best choice would be a dentist with English as a mother tongue or at least a Dentist that has studied/practiced for many years in an English speaking country. A good alternative for such proof reading is to seek the help of professional scientific editorial services (e.g. www.oleng.com.au, contact@savantproofreading.com, http://oakfortressproofreading.com).

Omitting this last step may be detrimental and may lead to the rejection of the manuscript, since in my personal experience the most frequent complaint of reviewers is about poor language.

Before submission every author must read the final version and approve it. This is necessary, because being on the author line, every author takes scientific/intellectual responsibility for the manuscript!

4.2. The review process

The standard mode for submission is the internet. Most editors/publishers provide templates to guide authors through the submission process. Usually the first step is that the editor/publisher checks if the manuscript complies with the formalism. Many are very careful about the question if the content is new and original (high probability to be published) or if the content is new, but basically confirming existing knowledge (high risk of being rejected). Then the decision is made if it should be sent into the review process. Most Journals use a blind review performed by at least two reviewers. The main purpose of the review process is to improve the paper, therefore if reviewers find detrimental flaws in "Materials & Methods", this is usually a reason for rejection, since the paper cannot be salvaged. On the other hand, if the authors were not able to explain what was really done in "Materials & Methods", then the reviewer does not understand it and recommends rejection as well. Many reviewers do a simple test by computing the number of cells as described in the experimental design and compare it with the total # of samples produced (e.g. 3 materials x 2 shades and 3 treatments = 3x2x3= 18 cells; if the author reports that 200 samples were made, then 200/18 = 11,11 ergo something is wrong, since n can be 11 or 12 only). If the resulting n is not a single number then something is wrong and the paper in the best case goes back to the authors.

Many papers get rejected outright, very few are accepted without modifications/revisions. This means they are sent back to the authors with comments and requests for modifications. This causes frustration at first glance and the authors may get emotional, since they had tried to do the best. But remember the objective of the reviewers is to improve the paper, therefore authors should not object to the reviewer's comments unless really justified and return the manuscript with minimal revisions only. I have personally experienced many cases where the revised paper was sent the second time to the reviewers and came back with the recommendation "reject" and the comment

Table 2. Example how results should be presented: Tensile bond strength of ceramics contaminated with saliva after different cleaning procedures.

	After contamination cleaned with				
	Control	**Water spray**	**H_3PO_4 gel**	**polishing paste**	**Cleaner**
Ceramic 1	55.9±9.2[ab1]	21±13.6[c1]	40.6±10.7[b1]	29.7±15.2[c1]	54.2±8.8[ab1]
Ceramic 2	52.1±10.9[a1]	15.8±16.1[c1]	26.7±11.8[c2]	21.9±14.2[c1]	46.3±7.9[a1]

ANOVA, Tukey post hoc test p<0.01. superscript letters show same statistical groups in rows, superscript numbers show same statistical groups in columns

Table 3. Comments of reviewers, actions taken by authors and comments of authors for the reviewers.

Line	Comments of Reviewer	Action taken	Comment of Author
		Requested changes were done using the Track changes function in Word, so the reviewer can follow them. Additionally a manuscript was submitted without visible changes for the production of the layout.	
	Well done systematic description and analysis of the problem. Few changes required		thank you
27	The statement "The monopolization of Grant research has shifted research towards "safe" studies" is to general and must be backed with literature	The content was expanded with the following sentences: xxxxx and 3 Literature were added to the References list.	Thank you, very valid comment
247	The reviewer disagrees with the following " The peer reviewed system which is basically a good idea has become very ineffective and is more hindering research than improving its quality"	Added the following sentence: Since the acceptance rate has dropped to below 8% (due to financial restraints and growing number of submissions), it means that one granted project yields 12 submissions for the author and requires 12X3 = 36 peer reviews, which binds resources of researchers cannot be effective and efficient.	The Author maintains this view, but has added more explanations to substantiate it.

that authors did not follow the recommendations for improvement. Therefore the recommendation is that the authors compile all comments of the reviewers into a table with one line per comment. Then they should add two more columns. In the first they should address the comments and let the reviewer know what they did or give reasons why they did NOT do any changes. In the other column the changes can be displayed (Tab. 3). This approach may further speed up the review process, since having very good explanations about the changes the editor may decide based on such a table rather than send it for the second time to the reviewers.

5. Conclusions

• research is exciting
• hard work is often boring
• writing follows standard rules -> boring
• with precision, know how, and the right attitude there is a very high chance for success

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References

1. Biedermann M. Projekte managen. ATW Verlag, Buchs SG, Switzerland; 2009.
2. Roulet J-F, Viohl J. Der Weg zum Doktorhut. Quintessenz Berlin 2. Auflage; 2006.
3. Roulet JF. Why Peer Review? Stoma Edu J. 2014;1(1):6.
4. Roulet JF. Open Access Publishing. Stoma Edu J. 2016;3(2):122.
5. ***Budapest Open Access Initiative 2003. [Internet: available http://www.budapestopenaccessinitiative.org/read. Last accessed 8th April 2017].
6. van Meerbeek B, Roulet JF. Open-access Journals - A Scientific Thriller. J Adhes Dent. 2013;15(6):503-504. doi: 10.3290/j.jad.a31107
[Full text links] [PubMed] Google Scholar(2) Scopus(1)
7. Bonannon J. Who's afraid of peer review? Science. 2013;342(6154):60-65. doi: 10.1126/science.342.6154.60.
[Full text links] [PubMed] Google Scholar(753)
8. Bennett KJ, Sackett DL, Haynes RB, et al. A controlled trial of teaching critical appraisal of clinical literature to medical students. JAMA. 1987;257(18):2451-2454. doi:10.1001/jama.1987.03390180069025
[Full text links] [PubMed] Google Scholar(248) Scopus(112)
9. Sackett DL, Rosenberg WM, Gray JA, et al. Evidence based medicine: what it is and what it isn't. BMJ. 1996;312(7023):71-72.
[Full text links] [Free PMC Article] [PubMed] Google Scholar(14775) Scopus(7410)
10. Greenhalgh T. How to read a paper. Getting your

bearings (deciding what the paper is about). BMJ. 1997;315(7102):243-246.
[Full text links] [Free PMC Article] [PubMed] Google Scholar(232) Scopus(117)

11. Greenhalgh T. Assessing the methodological quality of published papers. BMJ 1997;315(7103):305-308. Review.
[Full text links] [Free PMC Article] [PubMed] Google Scholar(290) Scopus(138)
12. Roulet JF, Friedmann A. Evidence based – eine Medallie mit 2 Seiten. Prophylaxe Impuls 2015;20:115.
13. Layton D. A critical review of search strategies used in recent systematic reviews published in selected prosthodontic and implant-related journals: Are systematic reviews really systematic? Int J Prosthodont. 2017;30(1):13-21. Review. doi: 10.11607/ijp.5193.
[PubMed] Google Scholar(2)
14. Taylor BN, Thompson A. The international system of units (SI). NIST Special Publication 330, 2008 Edition National Institute of Standards and Technology, Gaithersburg, MD 20899. [Internet: available http://physics.nist.gov/Pubs/SP330/sp330.pdf. Last accessed 8th April 2017].
15. ***World Medical Association. WMA declaration of Helsinki – Ethical principles for medical research involving human subjects (1964, last update 2013). [Internet: available https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/. Last accessed 8th April 2017].
16. ***Food and Drug Administration. Code of Federal Regulations. 21 CFR Parts 210 & 211. GMP Publications 2017. [Internet: available http://www.gmppublications.com/210211DrugGMPs.htm. Last accessed 8th April 2017].
17. Matthews DE, Farewell V. Using and understanding medical statistics. Karger, Basel, Switzerland; 1985.
Google Scholar(70)
18. Remington RD, Schork MA. Statistics with applications to the biological and health sciences. Prentice-Hall, Englewood Cliffs NJ, USA; 1970.
Google Scholar(1331)
19. Neter J, Wassermann W. Applied linear statistical models. R.D. Irwin, Homewood IL, USA; 1974
Google Scholar(25287)
20. Roulet JF. Good ideas have many fathers. J Adhes Dent. 2005;7(3):179.
21. Layton DM, Clarke M. Accuracy of medical subject heading indexing of dental survival analyses. Int J Prosthodont. 2014;27(3):236-244. doi: 10.11607/ijp.3633
[PubMed] Google Scholar(8) Scopus(7)
22. Layton DM, Clarke M. Will your article be found? Authors choose a confusing variety of words to describe dental survival analyses. Clin Oral Implants Res. 2015;26(1):115-122. doi: 10.1111/clr.12297
[Full text links] [PubMed] Google Scholar(5) Scopus(6)
23. Layton DM, Clarke M. Quality of reporting of dental survival analyses. J Oral Rehabil. 2014;41(12):928-940. doi: 10.1111/joor.12217
[Full text links] [PubMed] Google Scholar(5) Scopus(5)

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Questions

There are many reasons why people do research. What reason should not exist:

❑a. Obtain a title;
❑b. Obtain/maintain a position;
❑c. Obtain grant money;
❑d. "L'art pour l'art".

The "Material and Methods" section contains:

❑a. Explanations why the materials were used;
❑b. Explanations why the used method was selected;
❑c. Reasons for the outcome;
❑d. Tables and figures.

What should a mentor not do?

❑a. Provide guidelines;
❑b. Provide instructions for use;
❑c. Provide templates;
❑d. Do the work.

What part is not in the structure of a scientific paper:

❑a. Introduction;
❑b. Material and methods;
❑c. Results;
❑d. Acknowledgements.