

COMMUNICATION

On the role of publications in science education and the question of their impact and evaluation

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Publications play a central role when it comes to evaluation and review in the academia. They are important in cases of promotion, tenure or distribution of resources. There exists, however, a huge variety of publication types in science education. Types range from peer-reviewed international journals, via books and teacher journals, towards textbooks and teaching materials, both in national languages and in English. The different formats correspond to all the varying fields and tasks of science education research, development, or teacher education. This communication intends to provoke discussion how to value and relate the different formats to avoid only valuing dissemination and implementation of science education outcomes by peer-reviewed, English language journals.

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The problem of evaluating publication portfolios in science education

Objectives and challenges in science education are diverse. In addition to science education research, science education groups are regularly engaged in pre-service teacher education, pedagogical and curricular innovation (whether research-based or not), teacher continuing professional development, teaching materials creation (including but not limited to developing textbooks), or science communication and other outreach activities. All these activities might focus on school education, higher education, non-formal and informal educational settings, teacher education, lifelong learning, or any combination thereof.

Each of the above mentioned areas lies within the realm of science education, each of them can be considered contributing to the academic worth of science education, but also being valuable in developing the field of science teaching and learning. In various countries, traditions vary greatly when it comes to the evaluation of productivity of science education research groups or individuals, e.g. in questions of tenure, promotion, or resources distribution. Generally, publications play a central role when it comes to evaluation and review in the academia. However, as there are so many different tasks and aims in science education a huge variety of publication types exists. Different formats correspond to varying fields of science education. They range from

peer-reviewed international journals, via books and teacher journals, towards textbooks and teaching materials.

In some countries or institutions, what counts is only the academic output in the form of peer-reviewed, English-language international journal articles (maybe even only those indexed by the Web of Science). In this case danger exists that science educators deviate themselves from the practice field and the practitioners' needs. Also risk exists that the research community does not reach the practitioners, since academic research publications are often not read by teachers, be it stem from missing access, academic language, and language barriers in case of readers from non-English speaking communities. In some countries, practices exist that the majority of science educators only publish in national language journals, sometimes even in (non-peer-reviewed) teacher journals or school textbook literature only. Also here risks exist. The teachers are addressed directly, but this is often done without sufficient connection to the current state of the art in international science education research. It is clearly suggested that both areas of science education communication are needed to secure both being an accepted academic research discipline and at the same time helping teachers in their practices. Luckily, some universities accept both kinds of publications for promotion. However, in counting both within competitive reviews the question arises how to come to a balanced weighing of one type of publication against another.

Why to stay with publications for evaluating science education researchers' productivity?

On different reasons, the performance of a science education research group or individual science educator needs to be assessed. Measurement might be needed in tenure or promotion applications, in competitive calls for vacant positions, or when it comes to distribution of resources and grants. In all these cases, the yield of publications is a fundamental yardstick.

In questions of resource distribution within a university it might be even needed to compare groups or persons working in different fields. This is especially delicate if the science education group is part of a science department since science, other than science education, possesses a much more coherent, sorted and settled system of publications and publication metrics.

One should argue that every academic discipline has its own tradition of publishing and own publication formats. Different disciplines have large varying average impact factors or citation counts. Thus, research success should be measured and evaluated with much caution. However, if science education is a self-standing field of academic practice within general education or its corresponding science background discipline, it has to develop and tell its own story and define its own quality measures. Science education needs to be at least coherently assessable in itself.

Success in science education can have many indicators, be it third-party funding or numbers of MEd and doctoral theses produced. However, projects and theses only will get influence and recognition either to the academic field of science education or practice if they become communicated by publication to all the communities of researchers, practitioners, and

educational policy makers. External funding quotas or many theses do not have broad impact as long as they are not mediated through publication. Impact of projects depends on whether results are available to the scientific community beyond the direct effects from within the project. In all, it can be stated that many indicators of success of academic science education work can be measured directly and indirectly by analyzing all the different kinds of corresponding publications.

Towards a self-standing way of evaluating science education publications

Science education is different from general education and it is different from science. This claim concerns both its research traditions as well as its connection to the field of practice. If science education wants to continue to develop itself as a growing academic field on its own right and at eye level with others there needs to be a justification of our own culture and identity (Fensham, 2004). In searching for its own identity, a suggestion from within for a measure (benchmark) might be a helpful step. Such a measure needs to be applicable in both cases that the science education group is in the educational department, or is part of the faculty of science. A need for our own measure applies especially to science education when it is located in a department of science. The publication culture in science is almost exclusively based on peer-reviewed international journals in English language, whereas a lot of educational literature is published on good reasons in national languages be it caused to respect the cultural traditions of the field in question as well as to communicate the achievements to the groups of practitioners and educational policy makers within the country in question.

Education in general and school education in particular in most countries are mainly delivered in national and regional languages, only for some of them it is English. Also, research and innovation in science education mainly is done in national languages and in the foreground of the national standards and regional curricula, their traditions, and cultural backgrounds. An exclusive focus on assessment of science education activity by refereed, international research journals might therefore not be adequate to represent many achievements, if they are not easily being transferable into international English language publications. This concerns especially the broad mission of developing the curriculum and pedagogy. In particular, the order to devote oneself to the innovation of local practice (at home) is often not even indirectly met through these types of publications. This mission is fulfilled rather by the creation of textbooks, instructional materials, or via reports in teacher journals. Since this is an important task for science educators as well, it is suggested that these publications must also have a value in the assessment and evaluation of the performance of science education groups or individuals. Without recognition of this kind of work, science education needs to decouple from the practice field (must disconnect to their own reputation's sake). This would foster the already existing "two-communities-problem" between researchers and practitioners (Hubermann, 1993), or a potential three-communities-problem among researchers, practitioners, and those being in charge of defining and developing the curriculum in science education (De Jong, 2000).

Science education can only develop as an accepted academic field if it creates and justifies its scientific publication culture in itself, in which international exchange and evaluation are the rule, however the communication with practice in the same time will not be neglected. For this reason,

it is necessary that science education on the one hand develops a publication culture that will do justice as a research discipline and makes them acceptable to outsiders as such, especially the corresponding science disciplines. Such a culture is represented by reputed international journals, among others, such as *International Journal of Science Education*, *Journal of Research in Science Teaching*, or *Chemistry Education Research and Practice*, as well as books by reputed international publishing groups such as Springer, Routledge, or Sense. On the other hand, it must reappraise their results also in media made available to teachers and any other relevant actors in the educational field. These are practitioner journals, teaching manuals, instructional materials, and textbooks that are available at least in every bigger country and of which most are published in national or regional languages. Only a few of them, like *School Science Review* or *Education in Chemistry*, are spotted by an international audience because they are available in English language.

In different areas of science education work, different requirements apply for publishing. This relates to the length and language of the articles, the needed comprehensiveness of literature reviews, or the required theoretical depth of the manuscripts. Also the mechanisms of getting a paper published differ much and vary from invitations for writing without peer review, towards highly filtered procedures based on double-blind peer-review with rejections rates of over 90 percent. It is undisputed that it is much more demanding and time consuming to publish in international, peer-reviewed journals, especially research journals, as in national teacher journals. This also concerns the question whether the author is a native English speaker. Nevertheless, even these publications should count. Teacher journals may not have any impact in terms of traditional impact factor measurements, but might have a much bigger impact on classroom development and school innovation as compared to an article in any international research journal. The highest real impact on practice might have the school science textbooks, daily used by hundreds or thousands of school students in a certain country.

For relating both domains, namely the research literature and the practical literature, operating the classical mechanisms such as the impact factor or number of citations in SCI/SSCI are not applicable. Science education, if it intends to value both sides of the medal, needs to develop its own specific criteria and grid that weights the different types of publications under consideration of specificities of science education. Such a grid must take into account the whole range from teacher journals and textbooks on one hand, to refereed international research journals and major international book publications on the other.

A measure (norm) might take into consideration two dimensions: (1) The impact both on the academic audience as well as on practice (**Figure 1**), and (2) the demands to get a certain publication published both considering the demand to develop a manuscript as well as overcoming the hurdles to its publication (**Figure 2**).

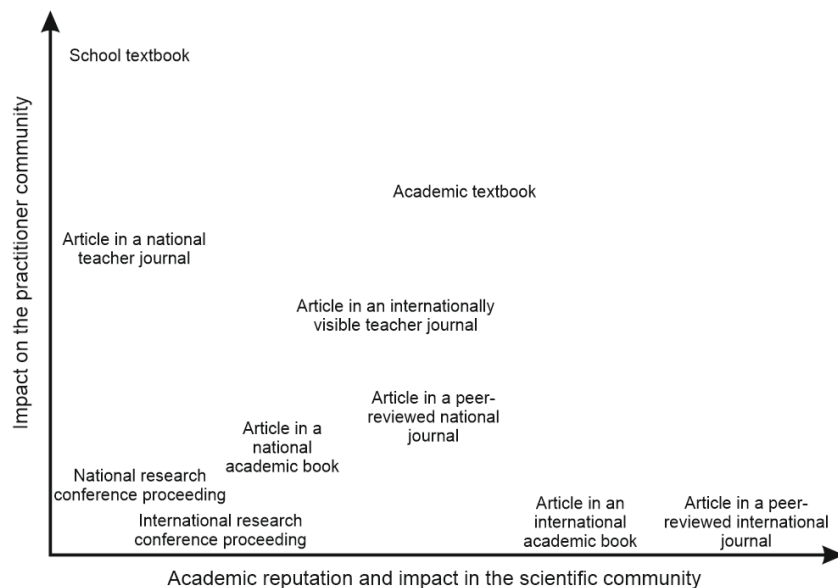


Figure 1. Impact of a publication on the scientific and practitioner communities

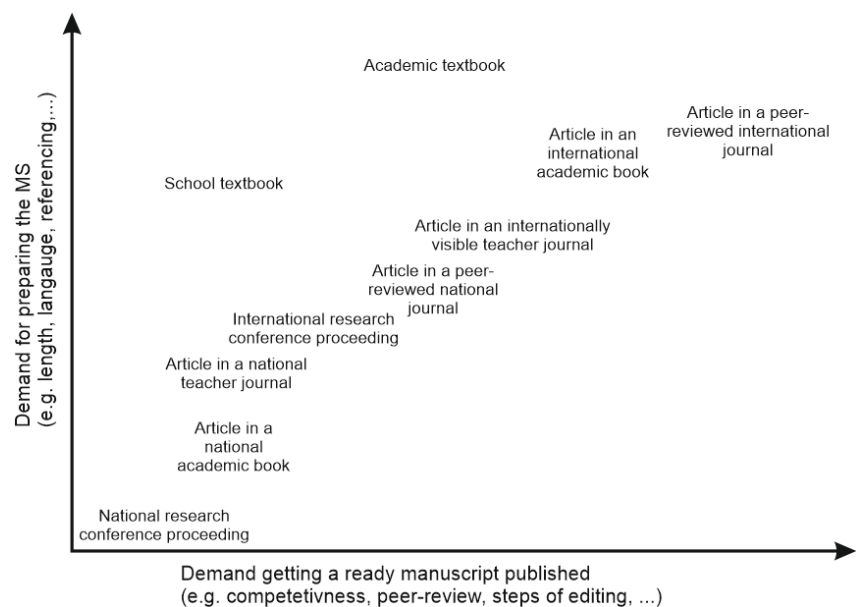


Figure 2. Demands to get a manuscript written and published

Towards establishing a norm

The following thoughts are personal views that for the case of any application would need negotiations within the science education community. The proposal is thought to initiate and provoke a discussion. This does not compete with potential other ways of assessing the success of science education groups or to make the achievements comparable with groups from other related disciplines.

Table 1 suggests weights of publications for assessment that were based on considering the following three aspects:

- Needed originality/innovativeness to get a manuscript published,
- Demand in manuscript preparation and probability to pass through editorial and review cycles, and
- Perception of importance as a contribution to the field of science education.

Table 1. A suggestions for weights of publications for assessment

Type*	Points**
National Publications	
Publication in an edited proceedings of a conference	1
Publication of a project report, pre-print etc.	1
Chapter in an edited book, textbook, or loose-leaf collection	2
Monograph, editorship of a book or textbook	3
Journal article in a teacher journal without peer-review	4
Journal article in a non-English language journal with peer-review	8
International Publications	
Publication in an edited proceedings of a conference without peer-review	2
Publication in proceedings of an international conference with peer-review	4
Chapter in an edited book	4
Monograph, editorship of a book or textbook	6
Journal article in a teacher journal without peer-review	6
Journal article in a journal with peer-review	12

* No differentiation is made within journals of the same type; national character means in national language and/or mainly visible to a limited national or national-language audience

** Print or online

In addition, among others, further thoughts might play a role in corresponding thoughts:

- Having a manuscript published in a reputed international research journal is difficult, the manuscripts are often quite long, and it is time consuming to get it published, especially for non-English native speakers. This alone would already justify a higher weighting factor. Additionally, a publication in an international journal is of great value for the reputation of the authors' own institutions and for the national scientific community and should be rewarded accordingly.
- Distinction should be made between journals with and without peer-review. However, different systems exist (blind, double blind). It might be suggested not to differentiate further between them in order to keep complexity limited. However, review only by one editor should not count as peer-review to respect established academic practices.
- For not overemphasizing one domain of science education over another it is suggested not to differentiate journals of the same kind if they only differ in focus, e. g. more focusing on empirical research reports, philosophical reflections on science teaching, or practical suggestions for the science classroom. It would make a certain kind of research publication rise above another, since only works with certain research focus might be published in certain international - as well as national – journals, e.g. in the *Journal of Chemical Education* vs. *International Journal of Science Education* (both international, both peer-reviewed).
- For journals that publish articles both practical and research the higher relative value is suggested, e.g. the *Journal of Chemical Education*. An examination of the individual topics and foci is suggested not to be made in terms of keeping complexity and effort low. For the same reason, also the length of the contributions is difficult to weigh. It may also be neglected for simplicity and differing academic traditions to weigh the number of authors or the weight of the first- or senior-authorship. Such factors were easy to put on a purely quantitative basis. However, in some academic environments it is suggested to publish in (international) cooperation as an indicator for scientific quality, but this leads more often to multi-author papers. Some measures suggest the weight of authorship to decrease by the order of appearance on the paper, denying the tradition that the senior-author (last mentioned) in many countries is the second important one after the first author.
- In the ideas presented in **Table 1**, it is also suggested to keep the gap between the different categories deliberately in order to take into account the specific areas of science education work. In many countries or institutions, a publication in the journal *Science Education* would count infinitely times more as compared to national teacher journals, since the latter do not count at all in academic evaluation in these countries or institutions. As it is delineated above we have a large variety in our publication culture, and this suggests that these magazines should have an impact (even if leaning more on practice). Although highly different from academic recognition in some countries, a not too low weighing is suggested for practical contributions. This will also avoid that young people in the field see themselves obliged only to publish in English language, research journals and thus might lose connection to the practitioner community.

Conclusion

Science education is a field in intersection of science and education. It is neither science nor general education. Science education groups are sometimes located in departments of education, and sometimes in faculties of science. Thus, science education is a bit in competition with both of them. This is mirrored in the culture of publications. Even in the two most accredited international journals in the case of in chemistry education this can be seen. For example, many articles in the *Journal of Chemical Education*, e.g. on new experiments, follow a structure of articles in chemistry journals. Other more research-based articles in that journal as well as most articles in *Chemistry Education Research and Practice* are more structured as in journals in general or other fields of education.

If science education is not intend to lose impact on practice it needs to find its way between fundamental empirical research and classroom innovation, even if the latter one is developed by unconventional models of research, such as action research (Laudonia, Mamlok-Naaman, Abels & Eilks, 2017) or the many other forms of educational design research (Plomp & Nieveen, 2010). Science education needs to be brave enough to define its own standards that cover both orientations of science education, in academic research groups and beyond. Such a discussion needs to take place to keep and extend the room science education has in the academia. There is still much to do.

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