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Book Review

Review of Haglund, J., Jeppsson, F., & Schönborn, K. J. (2022) Thermal Cameras in Science Education

Heidelberg: Springer Nature.
https://link.springer.com/book/10.1007/978-3-030-85288-7

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1. Scope and content overview

The use of infrared cameras and thermal imaging in scientific education is a fast-growing field, and this book provides a timely collection of current research and development on the subject. The editors have organized a total of 13 contributions into three parts:

- Part I Thermal Imaging Technology and Physics
- Part II Science Education Research on the Use of Infrared Cameras
- Part III Using Infrared Cameras in Science Teaching Practice

I will now present some highlights, discuss a few limitations, and end with a couple of concluding remarks.

2. Some highlights

A first highlight is certainly the fact that the book, with its three-part structure, offers a combination of scientific background, science education research, and science teaching practice – not a common, but most useful and stimulating format. One would like to see many more books of this type.
Another highlight is the contribution on "Fundamentals of Thermal Imaging" by Michal Vollmer (chapter 2), providing the necessary physics and instrumentation background for the topic. Vollmer has extensively published in the field, including many creative and stimulating applications in science education, and is certainly one of the best authors one can find for such a background chapter. I have particularly liked e.g. the clear exposition of the "Radiometric Chain" for the thermometric measurement process, and the discussion of the specifications of a series of current IR cameras, very useful for an assessment and understanding of the educational activities presented in the following chapters.
Regarding science education research, the contribution by Christopher Robin Samuelsson (chapter 4) provides a review on "Research on Educational Use of Thermal Cameras in Science" which is well-written and very useful – in fact, it is the first review of this kind I know of.
Last but not least, I would like to mention the contributions in the part on science education practice, which provide a rich and stimulating image of field, e.g.:

- Infrared Cameras as Smartphone Accessory: Qualitative Visualization or Quantitative Measurement? (chapter 9), by Michael Vollmer;
- An Infrared Camera: Multiple Ways to Use a Modern Device in Introductory Physics Courses (chapter 10), by Gorazd Planinšic, Urška Nered, and Eugenia Etkina;
- Infrared Thermal Imaging: Applications for Physics, Chemistry and Biology Education (chapter 11); by
- Choun Pei Wong and R. Subramaniam;
- Visualizing and Exploring Heat in a Science Center, (chapter 12), by Karljohan Lundin Palmerius and Konrad J. Schönborn.

Two of these contributions extend the scope of the book in interesting ways, to scientific fields other than physics (chapter 11), and to non-formal science learning (chapter 12).

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I want to mention two examples from this group of contributions which nicely demonstrate their high quality. First, the experiment "Shooting a Glass Marble Through a Cardboard" presented by Planinšic et al., (chapter 10), provides a good illustration of the visualisation potential of thermal images. The activity is complemented by an estimation of the temperature increase, a nice example for "Thermal Infrared Imaging as a Bridge Between Mathematical Models and the Laboratory", as it is formulated as title of chapter 3 (by Stefano Oss). Another example is the analysis on "Infrared Cameras as Smartphone Accessory: Qualitative Visualization or Quantitative Measurement? (chapter 9, also by M. Vollmer). It is only through these external devices that thermal imaging will be accessible in standard schools with a limited budget for science equipment, and the chapter provides a timely and well-balanced overview of what is possible with the help of such devices and what is not.
One of these recommendations is of special importance: While the integration of thermal imaging in schools is very desirable, it has to be complemented by appropriate training programs for teachers if one wants to go any further than colorful images as qualitative visualization. The topic involves non-trivial physics, and for a quantitative analysis of IR images, one needs detailed understanding of the physics background as well as how the camera and its software function. This is a highly relevant observation, especially in times where the integration of "digital competences" into schools is required everywhere, yet budgets often allocate minimal resources for teacher training, focusing primarily on hardware and software.

3. Limitations: a blind spot, and "splendid isolation"

A minor limitation has to be stated with regard to the title "Thermal Cameras in Science Education". The scope of the book is in fact more restricted as the title would lead us to believe, because the majority of contributions is about physics education (or just physics). Very nice work has been done for instance by Xie for thermal cameras in chemistry education[1].
The only major limitations of the book concern the science education research part, and two aspects in particular should be mentioned here: In the four contributions reporting about individual studies, little to no quantitative data or analysis was provided. Second, there was no mention whatsoever of multiple representations, which is a strong strand of research of obvious interest for the topic of thermal images[2)-4)]. Coming back to the review by C. R Samuelsson (chapter 4), covering 16 empirical publications, he also states that the majority draws on a qualitative methodology. Moreover, he reports that "two frameworks seem to dominate on the theoretical side: Social semiotics [...] and the Resources framework".
Note that there is of course nothing wrong with qualitative methods, nor with these theoretical frameworks. The critical remark is that there are almost no quantitative considerations at all, and none on multiple representations in the whole book; due to this, the research documented in this volume is not wrong but limited in a consequential way. Let me give two examples for this: The contribution by Loukomies is about the affective dimension related to thermal images, certainly a topic of both high research interest and of practical importance. But while there is a plethora of quantitative methods and fine-graded studies on emotions, motivation, competence beliefs etc. (terms used by the authors), the contribution does not mention them, and even less tries to establish any link to this very large body of quantitative research. Moreover, there seem to be no studies of this kind at all in the field, and I would consider this as serious research gap or kind of blind spot.
Similarly, there is a very large body of theoretical background and empirical evidence on multiple representations in science education, as well as learning obstacles and learning approaches related to them[5)]. Again, while the contribution by Niclas Åhman and Fredrik Jeppsson (chapter 7), which takes a social semiotics based stance towards students' practical work with IR cameras, is certainly interesting, (multiple) representations are mentioned in the introduction, but then no link whatsoever is made to this perspective. For instance, the foundational work by Ainsworth about the educational functions and values of multiple representations[6)] is not cited (and nowhere else in the entire book). I see this as a type of "splendid isolation" between different schools of thought, not uncommon by the way to many areas in (science) education.

4. By way of conclusion

This being said, the above limitations do not so much apply to the book as such, but rather reflect the current state of research in the field, which the book correctly reflects. I deliberately avoid the word 'weakness' and use 'limitations' instead, as they are a natural part of any scientific discussion. Moreover, considering the many highlights of the book, especially its approach of integrating science background, science education research, and science teaching practice, I warmly recommend it to any researcher or practitioner in the field.

Sources

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