CHAPTER EIGHT
Neuroimaging and evidence-based learning: reflections with potential end-users

“We have to look for what new knowledge brain research can bring to the table.”

[teacher]
Abstract

Insights gained from neuroimaging methods have the potential to contribute to a new kind of evidence base for the practice of education. In order to contribute to knowledge that is more socially robust, we reflected with end-users of education in the Netherlands on perceived opportunities and concerns associated with applying insights from neuroimaging studies to education, taking into account the context of its application. We conducted three focus groups with parents (n=21) of children attending secondary school, three focus groups secondary school teachers (n=20) and four focus groups with secondary school children aged 16-17 (n=28). Our results show a variety of ways in which evidence from neuroimaging is framed, related to participants’ ideas about the validity of the evidence, considerations about other types of scientific and non-scientific evidence, and opinions on the importance of basing educational methods on scientific evidence.

8.1 Introduction

Scientific knowledge about the structure and function of the brain has increased exponentially in the past decades. Not only do these developments contribute to our understanding of the brain, they also provide many opportunities for application outside the lab and clinic. Perhaps unsurprisingly, the domain of education is one of the most promising fields that might benefit significantly from neuroscientific evidence for effective learning environments, methods and techniques. The emerging field of ‘neuroeducation’ applies these insights to educational settings (Ansari et al., 2011b), providing a new perspective on learning. Also Carew and Magsamen (2010) argue that
neuroscience and education are an ideal partnership for producing evidence-based solutions to guide 21st century learning:

“We could continue to imagine a million things that are possible when fuelled by evidence-based rigorous neuroscience research that can be translated to practical application and tested for their efficacy through the creation of research schools, informal learning testing, and other measures. These game-changers for education and learning are within our reach” (p. 686).

The idea that education should become more evidence-based is increasingly accepted in many countries around the world (for an overview see Biesta, 2007). Pasquinelli (2011) describes three trends contributing to this development: the overall sense that education is in need of reform; the idea that education is too valuable to be influenced by “prejudice and bias in name of tradition” (p. 187); and the influence of the practice of evidence-based healthcare.

Although the field of neuroeducation emphasizes neuroscientific evidence for learning and education, this is but one of the different kinds of evidence present and used in educational practice. Other types of evidence that are frequently referred to are, for example, results from behavioural research and educational research, but also the professional experience of teachers. This so-called practical or experiential knowledge has become more accepted as evidence since the middle of the 20th century (Caron-Flinterman et al., 2005), the practical knowledge of teachers is argued to constitute the starting point for educational change (Van Driel et al., 2001).

This being said, neurocognitive research seems to have a special status compared to other types of evidence (Biesta, 2007). In their article on neuroethics and education, Sheridan et al. (2006) discuss whether, in the middle of the plurality of values, demand for resources and politics that pressurize this field of education, empirical advances within neurocognitive sciences could be conceived of as an “aligning force”.

The techniques that have been most successful in advancing cognitive neuroscience are neuroimaging methods like fMRI and EEG, which noninvasively track changes in cerebral blood flow and the electrical activity of the brain respectively (Antonenko et al., 2014). Neuroimaging technologies make it possible to see changes in brain
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activity and have helped scientists gain increased insight into brain mechanisms involved in, amongst others, memory formation (Euston et al., 2012; Schacter et al., 2012), language acquisition (Friederici, 2011; Kuhl, 2011) and mathematical proficiency (Price et al., 2013; Zamarian et al., 2009). On the other hand, scientific literature also articulates certain concerns with respect to the appreciation of neuroimaging in educational practice, constraining its responsible embedding. A few scholars of both neuroscience and sociology have warned against the seductive allure of information based on brain research. Weisberg and colleagues (2008) have empirically demonstrated that irrelevant neuroscience information interferes with people’s ability to assess the quality of the explanation of psychological phenomena. More recently, Ali et al. (2014) have shown that this “neuroenchantment” can convince, to some extent, undergraduates of neuroscience and psychology of the unlikely results of a mock brain scanner in combination with a magic trick.

Connors and Singh (2009) emphasize that educational practice and policy is already being influenced by the persuasiveness of imaging, which has given rise to new generalized neuroscientific truths about children, such as how the difference between boys’ and girls’ brains shapes their ability. Johnson and Littlefield (2011) argue that the translation of neuroscientific research into the popular press is often accompanied by claims of certainty, the translator having less fear of being challenged by his audience than the original scientist-author. They maintain that the consequences of translating these findings into brain-based education policy could be harmful when they concern issues of normative or cultural importance. This has led many scholars to caution neuroscientists against contributing to the proliferation of pervasive “neuromyths” (see for example Ansari & Coch, 2006; Goswami, 2004; Howard-Jones & Fenton, 2011; Maxwell & Racine, 2012; Pasquinelli, 2012).

How one values the application of neuroimaging findings to the practice of education ultimately depends on the way neuroimaging is framed as a type of evidence. Schön and Rein (1995) describe ‘framing’ as the way that people make sense of a complex situation or problem by selecting certain features and relations that they consider important. The resulting frame consists of underlying structures of belief, perception and appreciation that are - in this case - used to make sense of neuroimaging research as an evidence base. The abovementioned critique of neuroimaging seems to warn us for an overly narrow positivistic framing of neuroscientific evidence. It has, however,
not been investigated extensively how actors in the educational practice actually approach neuroimaging-derived evidence, also in relation to other types of evidence. The interpretations and expectations of these actors (potential future users) at least partly determine the success of neuroimaging in educational practice. In order to contribute to a responsible embedding of neuroimaging in education, we therefore aimed to gain insight into how the end-users of education perceive the evidence base created by neuroimaging compared to other types of evidence. We describe the outcomes of reflections with teachers, parents and students of secondary schools in the Netherlands and the way they ‘frame’ different kinds of evidence.

The Netherlands has been taken as the setting of this study. The Dutch research program Brain & Cognition: Societal Innovation (HCMI) website (2013) posits ‘the application of rapidly accumulating knowledge on the development of the brain’ as an answer to ‘demand for evidence-based education renewal’. In addition, evidence-based education has become a key component of the Dutch research agenda with the establishment of the Top Institute for Evidence Based Education Research (TIER) in 2008. The Dutch secondary education system has a particular educational structure, being divided into three streams with different levels. These three streams are a four-year course of pre-vocational secondary education (VMBO\textsuperscript{15}), a five-year course of senior general secondary education (HAVO\textsuperscript{16}) preparing students for a university of applied sciences, and a six-year course of pre-university education (VWO\textsuperscript{17}). Students are assigned into one of these streams based on a combination of three factors: school performance at the elementary level, the advice of the primary school officials and the student score on a nationally taken test, the CITO test. Besides this early selection, Dutch education is further characterized by the freedom to select one’s own school within the assigned stream, and a high level of autonomy for HAVO and VWO students.\textsuperscript{18} In the past decade, the Netherlands has seen far-reaching changes to its education system with the goal of stimulating independent learning and improving

\textsuperscript{15} Literally: preparatory middle-level applied education
\textsuperscript{16} Literally: higher general continued education
\textsuperscript{17} Literally: preparatory scholarly education
\textsuperscript{18} For more information secondary school system in the Netherlands, see the website of the Dutch Ministry of Education, Culture and Science, accessible at \url{http://www.government.nl/ministries/ocw}. For a comparison of the Netherlands with other European countries, specifically see \url{http://www.trendsinbeeld.minocw.nl/grafieken/2_1_2.php} (last accessed August 17, 2014)
students transition to tertiary education. However, this top-down reform has been met with quite some resistance amongst teachers and students, which lead to a parliamentary inquiry (Bronneman-Helmers, 2008).

8.2 Methods

In order to gain insight into the perceptions and values regarding neuroimaging evidence of those involved in the practice of education we conducted focus groups with potential end-users: parents of children attending secondary school, secondary school teachers and secondary school students. The focus group methodology has as advantage that the interaction between participants highlights their attitudes, priorities, language and framework of understanding (Kitzinger, 1994).

A recruitment agency with a large database in Amsterdam was used to find parents and teachers willing to participate for a small fee (max. 40 euro). All participating students attended one particular school in Amsterdam, and were selected randomly from four secondary school classes. Students were between 16 and 17 years old and attended the focus groups as part of their philosophy lessons.

In total ten focus groups with potential end-users were conducted: three focus groups with randomly selected parents of one or more children attending secondary school at different levels (n=21), three focus groups with randomly selected secondary school teachers of different subjects at different levels (n=20) and four focus groups with secondary school students attending 5VWO (n=28). Table 8.1 gives an overview of the focus groups.

The focus groups with parents and teachers lasted for two hours and the focus groups with students lasted for 80 minutes, due to time constrictions in their class schedule. The focus group with students made use of a design that differed superficially from the design used with teachers and parents in order to make the topic more appealing to them, as shown below. However, all focus groups consisted of four main phases in which key ideas of ‘quality of education’, ‘evidence-based learning’ and ‘neuroimaging as an evidence base’ were introduced in a step-by-step manner, in order to make it possible to separately discuss these different facets of the use of neuroimaging as an evidence base for education.
Table 8.1. Description of focus groups

<table>
<thead>
<tr>
<th>Focus group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
<tr>
<td>Teachers</td>
<td>n=7 (4 m, 3 f)</td>
<td>n=6 (2 m, 4 f)</td>
<td>n=7 (3 m, 4 f)</td>
<td>n/a</td>
</tr>
<tr>
<td>(120 min)</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Age</td>
<td>28-49</td>
<td>21-63</td>
<td>28-60</td>
<td></td>
</tr>
<tr>
<td>Level</td>
<td>Havo/vwo: 2</td>
<td>Havo/vwo: 2</td>
<td>Havo/vwo: 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vmbo: 5</td>
<td>Vmbo: 4</td>
<td>Vmbo: 5</td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td>Philosophy,</td>
<td>Social sciences,</td>
<td>English,</td>
<td></td>
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<tr>
<td>subjects</td>
<td>technology,</td>
<td>physics,</td>
<td>German,</td>
<td></td>
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<td></td>
<td>history,</td>
<td>geography,</td>
<td>‘health and</td>
<td></td>
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<tr>
<td></td>
<td>Spanish</td>
<td>history, art,</td>
<td>wellbeing’</td>
<td></td>
</tr>
<tr>
<td>Parents</td>
<td>n= 8 (4 m, 4 f)</td>
<td>n=7 (3 m, 4 f)</td>
<td>n=6 (2 m, 4 f)</td>
<td>n/a</td>
</tr>
<tr>
<td>(120 min)</td>
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</tr>
<tr>
<td>Age</td>
<td>38-57</td>
<td>39-56</td>
<td>35-54</td>
<td></td>
</tr>
<tr>
<td>Child’s</td>
<td>Vwo: 3</td>
<td>Vwo: 2</td>
<td>Vwo: 1</td>
<td></td>
</tr>
<tr>
<td>School type</td>
<td>Havo: 2</td>
<td>Havo: 2</td>
<td>Havo:2</td>
<td></td>
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<tr>
<td></td>
<td>Vmbo: 3</td>
<td>Vmbo: 2</td>
<td>Vmbo: 3</td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td>n= 7 (3 m, 4 f)</td>
<td>n=7 (4 m, 3 f)</td>
<td>n=7 (4 m, 3 f)</td>
<td>n=7 (3 m, 4 f)</td>
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<tr>
<td>(80 min)</td>
<td></td>
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</tbody>
</table>

Both focus group designs started off with a warming up exercise that integrated the additional aim of making a general inventory of participants’ ideas about what comprises good education. Students were asked to make a drawing of how they would like education to look if they travelled to 2060, while teachers and parents were asked to write down (on post-its) words they associated with the question “on what kind of knowledge teaching methods should be based.” The drawings and post-its were then discussed with the group.

The facilitator subsequently introduced a brief description of the concept of ‘neuroeducation’ and the technology of neuroimaging as a source of knowledge for education. In both focus groups, pictures of an fMRI scanner were shown and it was explained that neuroimaging is a technology “with which it is possible to visualize brain activity during certain tasks, giving insight into learning processes”. To gain a sense of the participants’ general understanding of neuroeducation and their basic attitude towards the technology of neuroimaging, teachers and parents were asked to make a drawing based on the first associations they had with neuroeducation, and
students were asked to write down their first associations on a post-it. These associations were then discussed.

Next, the facilitator presented the participants with three scenarios describing three different types of knowledge for developing or improving teaching methods. In the focus groups of parents and teachers, they were asked to place themselves in the shoes of a teacher, while students were asked to imagine they were part of a consultancy firm giving advice about teaching methods. Using these scenarios, the participants compared neuroimaging to evidence from education research and the teacher’s own experiential knowledge. The participants were asked “which type of evidence they thought was most convincing” and went on to discuss the benefits and drawbacks of the different methods. These were then prioritized. The aim of this comparison was to enable participants to be concrete about the strong and weak points of neuroimaging compared to other types of knowledge.

During the final step of the focus group with teachers and parents, we set out to gain an understanding of the conditions under which participants deemed ‘evidence’ to be important for education, by asking them if there was anything that they would be afraid to lose with this focus on evidence.

Focus groups were recorded after obtaining informed consent, and transcribed in full. A thematic analysis (Braun & Clarke, 2006) of the transcripts was conducted by RE and FK using Atlas.Ti. RE read and re-read the transcripts, coded them in detail, and grouped the different codes into general categories. Together with FK these were reviewed, defined and reflected on in an iterative process, leading to the definition of different themes relating to how participants perceived neuroimaging as an evidence base for education, and how they perceived the importance of evidence-based learning. These themes will be addressed below. As the participants themselves did not use the word ‘evidence’ that much, we defined evidence as ‘the basis on which participants justify their beliefs’, in this case, about what defines quality education.

8.3 Results

We start this section with a discussion on ‘good education’ and the role of evidence in education. We then present the considerations participants had with regard to the use
of neuroimaging as an evidence base for education and how this compared to other types of evidence. Although participants of the focus group discussions were asked to compare three types of evidence, the most dominant and interesting contrasts were found in the perception of neuroimaging evidence vis-a-vis personal experience. Therefore, we here only discuss these two types of evidence in subsequent sections. Evidence resulting from other types of researchers is referred to when relevant.

**Good education and the role of evidence**

The focus group participants mentioned many elements that were considered important aspects of the educational practice itself. They concern both the process and the outcomes of education.

With regard to the process of education, participants mentioned that education should be interactive, challenging, fun and social, should connect to the practice and daily life of students, speak to different senses, make use of new media and digital technologies, provide structure to the students, and differentiate between different groups. In most accounts of teachers’, parents’ and students’, the role of the teachers was considered pivotal. Participants mentioned many different attributes or characteristics that a teacher should have, like being clear, open, honest, engaged, communicative and consistent. In addition, a teacher should be both inspired and inspiring, and should not only have knowledge of the subject taught, but also have fun while teaching.

The participants also discussed the outcomes of education. Most participants mentioned the students’ grades as the most important outcome measure. If a whole class scored high on standardized tests, the lessons were of high quality. In addition, it was considered important to listen to the feedback of students, to see if they found the lessons interesting, enjoyable or too difficult or easy. A third, more general, outcome mentioned by some parents and teachers was that the child should be able to function within society after secondary school.

Clearly, in discussing the definition of good education, scientific evidence was not directly in the participants’ minds. Of all focus groups, only one participant mentioned scientific research as an important factor in the development of quality education before we introduced the concept of evidence. On the other hand, parents and
teachers often commented on their frustration that educational innovation – evidence-based or not – is often implemented top down, without recognizing the wishes of other parties.

As this parent explains:

“No, I really think that within education, the biggest issue is that people that are not working on the ground start making up ideas. [...] And even though there are all kinds of parents’ initiatives opposing the development, it still is pushed through.” [parent]

There was much critique regarding the way that education renewal plans were instated in the past in The Netherlands. This was perceived as having negative effects on their willingness to work with new methods, especially when they are forced upon the education system from above, as explained by a teacher:

“They sometimes say: it’s bad education, the way I have taught for years, the way with which I feel comfortable. If I have to do something I do not feel comfortable with, they can just eliminate me. I’m a very passionate teacher and really engaged with my students, otherwise I would never have taught at [this] level. But please, let me do it my way, don’t force a certain regime on me from above.” [teacher]

Besides not wanting to be forced to do something differently, this teacher makes clear that he needs to be able to work within his own comfort zone. He expresses the need to do it his own way, which relates to the degree of independence he requires. Many other teachers echoed this opinion. Some teachers simply did not feel like working with new insights if that required them to treat each individual student differently, for example:

Teacher 1: “I now have VMBO students, and at the beginning of the school year I have to make 19, yes 19, treatment plans. And I really feel I am not educated for that.”

Teacher 2: “You know what I feel… It makes me sick.”
Many participants also mentioned that new insights should be incurred at the cost of important social structures, norms and values, as this teacher explains in the following quote:

“We don’t know if that method of sixty years back was so bad. The only thing is, we are at such a different level nowadays. We say: boys and girls need to be together [in class], but scientifically I wouldn’t dare to argue that. But emotionally or socially, and for society, I would want to say that.” [teacher]

Neuroimaging as evidence for education

Various participants from all three user groups argued that knowledge derived from brain scans can be measured, so is tangible in a way. This sets neuroimaging apart from other types of research, as is argued by one of the parents:

“I find it to be very tangible. All those psychologists throughout the ages say they think certain things, but now finally we are able to measure something.” [parent]

In addition, some participants thought that neuroimaging could provide insight into more than a snapshot in time, as some oral or written tests do. They argued that this was possible because a scan provides insight into the underlying processes and structures of the brain that gives rise to behaviour.

Most participants of the focus groups also thought that research done with brain scans would be more ‘objective’ than other types of research evidence and, especially the students, viewed neuroimaging and neuroscience evidence as definite ‘facts’.

“Neuroimaging is an objective, concrete view of the brain that is not influenced by certain factors.” [student]

According to many participants, neuroimaging findings cannot be confounded because the person being scanned has no influence on what is measured and is not able to hide behind his/her behaviour. Brain scans provide direct access to the brain, allowing the researcher to see things that otherwise would be obscured, while in
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behavioural tests, such as in education research, the subject can fill in a form too quickly or act in a socially desirable way. In addition, some participants argued that researchers themselves could not influence what is measured. Therefore, neuroimaging research could be “trusted” more than education research.

However, another significant number of the participants, especially amongst the teachers, did not agree that neuroimaging would give rise to more objective evidence, because they did not consider neuroimaging to be an interpretation-free tool. Different arguments were given for this. First, the researcher has to decode and find meaning in the results of the scan. Second, the technology was not expected to be able to take into account the complexity of what happens at an individual level, both inside and outside of the brain. For example, some participants were afraid that the use of neuroimaging would disregard human emotions or the influence of environmental factors, as this student argues:

“I don’t think your personality and everything can be seen with the scan. I don’t think you can see… like the way in which you think. I think everybody differs in the way they were brought up. And they have different norms and values and ideas. I don’t think you can see all this with such a scan. I think there is more, besides the brain.” [student]

This quote reflects another question raised during the focus groups, as to whether or not neuroimaging can and should be used to make universal claims. The students, in particular, did not think that neuroimaging could be used to make general inferences based on scans done with a select number of students. Many argued against potential application of neuroimaging for education because they considered all students, teachers and practices to be very different. One of the students for example argued:

“You ignore all distinctions. You take the average as the standard.”
[student]

Not the technology itself, but the drawing of broad conclusions on the basis of small sample sizes was considered problematic. Some participants asked how large the samples would have to be and argued that a larger sample size would be necessary. Other participants considered it simply impossible to give general guidelines on how to treat individual learners, and questioned to what extent research results or scientific
theories could provide insight into the learning of every particular child. Some teachers argued that teaching methods are dependent on the composition of the group of students, describing their classes as wholes, in which learning emerges from the interaction of students in the same classroom. In the following quote a teacher puts emphasis on the social component of learning when he explains how he uses different methods for different classes:

“I used this strategy with all three of my groups and they are very different groups, and I simply realized that one particular kind of group cannot deal with it [this teaching strategy], it is too free for them. They are pupils that are only engaged with thoughts about how to get out of the lesson […], while others were completely engaged. So I differentiate between different groups of students.” [teacher]

A teacher also argued that the same method might not be as successful in some parts of The Netherlands as in other parts:

“I think that research is about large groups of people and yes, they are averages. But… we have the Bible belt in The Netherlands, but we also have a teacher in Zeeland19, and we have a teacher in Amsterdam. These are really different areas and I would rather [take into account] the experience of a teacher, than [rely on] the results of this research, which is about the whole country.” [teacher]

Another argument, made especially by teachers and parents, was based on past experience. They considered neuroimaging research to be no different from other research, only using a new tool. These participants stressed that scientific theories are constantly changing and approached new scientific developments with considerable scepticism. Some teachers complained that they were so frequently bombarded with new knowledge, they couldn’t see the forest for the trees. A number of personal stories were told about bad experiences with educational consulting agencies working with new research insights:

19 The Bible belt is a strongly religious region that, geographically, spreads as a belt across The Netherlands. Zeeland is a largely rural province in The Netherlands.
“The result of these kinds of fashions is that everyone is following some kind of dogma (...) And that’s what I think of these kinds of researches; there are always people who put it into practice and hijack the knowledge. That is the danger of it. No one keeps thinking rationally.” [teacher]

When asked to compare teaching experience to neuroimaging, a number of participants argued that they faced a false dilemma, because even when neuroimaging is used to develop new teaching methods, the teacher will have to implement and work with these methods in practice. The teacher was described as an intermediary between the brain scan and the student, a party that can never be taken out of the equation. Some teachers and students explained that the educational culture could not simply be changed if neuroscience research would give rise to more efficient or effective methods. Therefore, neuroimaging results should be critically assessed with regard to the extent to which they can enrich the current educational practice, as this teacher indicated:

“I think it would be an advantage if we would know generally how to trigger the brain, that is important I think. We have to look for what new knowledge brain research can bring to the table.” [teacher]

Another topic that intensified the discussion was the application of neuroimaging for personalized learning. We introduced neuroimaging as an instrument with which it is possible to gain general insight into the functional brain, but many participants easily made the step from differentiating between groups, to the scanning of individual children. On the one hand, thinking of these different levels of application sometimes muddled the discussion. Some participants took a rather rigid stance against neuroimaging because they did not want children to be scanned. One of the teachers explained why she thought neuroeducation was a scary concept:

“Well, I just saw all these different individuals and then I had the association with Hitler (...) I thought it was scary and eerie. I thought that everyone would be programmed. (...) It came across as being computer-controlled, or programmed.” [parent]
On the other hand, this discussion did make the concerns about the impact of evidence-based education on relations of trust between stakeholders and the danger of the imposition of standardized norms on the individual needs of learners explicit. Even though many participants put emphasis on all children being individual, spirited persons, some were worried that the technology would find its way into the school somehow and be employed to investigate individual children’s learning capacities, problems or talents. When asked to draw how they would envision the application of neuroimaging within the domain of education, many participants drew a child surrounded by all kinds of technology, as shown in figure 8.1. Individual brain scanning was encountered with a lot of fear because participants were afraid that this would lead to labelling, stigmatization or discrimination of children.

Nevertheless, many participants believed that findings from neuroscience could be an interesting addition to the usual teacher training activities. Although teachers often mentioned that they needed to receive extra time for this in their regular workweek, participants considered it important that teachers kept working to stay at the top of their game throughout their career by engaging in training activities or reading up on research findings themselves. However, neuroscience research was not considered a priority by any of our participants. Other types of adaptations to education, for example with regard to the digitalization of the classroom, were considered to be a better investment.

Figure 8.1. Drawings of two teachers’ associations with neuroeducation. In the drawing below, the sign says “information etc.”
Personal experience as evidence for education

Some participants did not join the discussion of whether neuroimaging is a more objective way of measuring than other kinds of research, because they did not consider the objectivity of evidence to be an important criterion for good evidence in the first place. These participants argued that the very subjectivity of education in the locality of the classroom was the most important aspect in determining the quality of education. Most of the claims made during the focus groups were based on the participants’ years of experience being the subject or object of teaching, or from the learning experiences of their children.

Particularly students and teachers placed emphasis throughout the focus groups on the amount of expertise that teachers build up while working at school, experience that, in their opinion, cannot be replaced by science and technology. Some teachers explained how they find a specific way of teaching and interacting with students that works for them, building up their own knowledge slowly. Each teacher has his or her own strengths, weaknesses and specific ways of managing a classroom, making choices based on their own character preferences. This type of experience was described by one of the teachers in the following way:

“I think that if you are a professional, you seamlessly feel how a class will react to you, you don’t need any knowledge for that.” [teacher]

Another teacher explained it as follows:

“If your question is how you can support children in the best way, then I assume a teacher keeps dossiers about his students. And then you also have the experience that is not in a dossier but in the teacher himself, and I can’t really specify what that is. But it’s a kind of gut feeling that you develop during your career, with which you can reasonably predict what the student will come face to face with. (...) That has to do with how a child approaches his work and it’s really hard to capture in tables and lists because… we’re talking about people in motion.” [teacher]

Furthermore, a few of the teachers explained that they tried out different ways of teaching, as described by this teacher:
Teacher: “Even though it might not sound ethical, it’s not really an experiment... I have three parallel VMBO classes and I do all kinds of different methods with them and then I can see better what works as a method.”
Facilitator: “Could you tell me a bit more about that? What do you do differently?”
Teacher: “Well for example, some time ago I had a good experience with this. We were done with the chapter (...) and I had a lesson left before the test (...) so the night before I had the idea to split up the class in three groups and to let them think up quiz questions for each other (...) and the winner would get a prize. Then they learn the whole chapter and are enjoying themselves as well.”
Facilitator: “But are you comparing groups then?”
Teacher: “Well, I did it with all three of my groups and they are really different and I noticed that there is one kind of group that cannot handle this kind of method, it’s too free for them, the students are only thinking about how to get out of the classroom as soon as possible. So this way I can make a distinction between different kinds of students.”

A few participants also argued that expertise does not always contribute to higher quality education. For example, in the following quote a teacher expresses the opinion that one person’s experience is inferior to many teachers’ combined experience in educational research:

“You cannot assume that a teacher is a good teacher. Even though he might have years of experience, if he has done the wrong thing for all those years ... if that is the basis on which he develops his teaching program... I would rather be safe and take the common factor of years of research with multiple people, how they experienced it.” [teacher]

Another important stakeholder, with knowledge about school practice, indicated mainly by teachers, is students themselves. For example, when asked “how do you know what works in school?”, a few teachers mentioned that they frequently give questionnaires to their students or try to get feedback in some other way. One teacher explains:
“It definitely has an added value, the questionnaire. The questions I have in my questionnaire are related to the way I teach, and the way you feel in the classroom. This really gives an input. Sometimes you have to switch, you have so many different groups of students, different cultures. (…) That doesn’t mean that if they say that you talk too much, I will talk less. But you can learn from it.” [teacher]

However, some participants, most notably a few teachers, did not agree that this type of knowledge was “real” or “valid” knowledge. Some participants believed the school to be a client-oriented business catering to the needs of the student, a free willed consumer of education. However, other participants were of the opinion that students are stakeholders without a real say in the matter, being too young to understand the purposes of education and to judge whether their education is of quality.

The third party having a stake in the matter and knowledge and experience of students’ learning, are the parents of school-going children. Parents thought they had the best knowledge of what would benefit their child, whereas teachers often considered the parents to be standing in between them and their pupils. In the following focus group excerpt, a parent expresses her frustration at the school system for adhering so much to standardized testing procedures.

Parent 1: “I’m just of the opinion, [as a parent] you just have the best sense of your child, you have material for comparison. And then a random somebody…”

Parent 2: “…a mollycoddle”

Parent 1: “With just this ABC test says no. But I’m sure that I’ll be proven right in four years.”

Clearly, the different stakeholders attach different value to their own experiential knowledge, which could arise from them having different interests at stake.

8.4 Conclusion and discussion

Conducting a focus group about the abstract notion of evidence, particularly in relation to a technology like neuroimaging, has proven to be complicated, but not
impossible. It was challenging to discuss the evidence-base of a technology that participants knew very little about and frequently was totally new to them. Our experience is that it is important to provide participants with a general idea of neuroimaging, without explaining the details of the technology, which often results in an ungrounded discussion about technical (im)possibilities. For scientists, the evidence this technology offers is often surrounded by uncertainty and contingency. For example, fMRI, one of the most promising brain imaging technologies, does not measure brain activity directly, requires complex statistical interpretation, can be argued to overemphasize a modular view of the brain because it is used to pinpoint specific areas of brain activity, requires an experimental setup involving a large and loud machine in which the subject must do certain tasks, and for the time being can only be used to say something about groups of participants (Árnason, 2010). In addition, opinions differ about what the future will bring with regard to, for example, individualized scanning and possible applications of insights to education. We argue that this is not a limitation of this study, but that this technology is therefore particularly suited for discussion with participants embedded in the context of application, without getting stuck on present-day technicalities.

In this research the choice was made to discuss evidence only with end users on the ground level of education, as this is the level in which the evidence ‘comes to life’. With this decision other important stakeholders of education (e.g. curriculum developers, publishers, members of school boards, administrators at different levels) have not been included. It would be interesting to investigate if these stakeholders have comparable perceptions, as they are most involved in policy decisions. Coburn et al. (2006) have found that perceptions of valid and appropriate evidence do differ per level of the school system. For example, it was more likely for top-level administrators to have faith in the promise of research to inform and improve student achievement than people at other levels of the system.

Furthermore, also at the ground level of education, our selection of participants was determined by the practical limitations we faced. It can be difficult to organize focus groups with participants who feel they know little about neuroimaging and feel they have little stake in it. For this reason, we opted to work with teachers and parents registered with a recruitment agency for a fee. This ensured that although the participants within the focus groups were homogenous with regard to the selection
criteria pertinent to this study, they were quite diverse in other respects. This is illustrated for example in the diversity of subjects taught by the teachers and the level of secondary school attended by the parents’ children. We consider this to be important because we were interested in gathering a large variety of framings, values and beliefs. However, in the case of students, we employed a different recruitment strategy resulting in more homogeneous groups of students all with a similar, high-level educational background who attended a course in philosophy. This has most likely influenced our results, as both the considerations regarding the consequences of such a technology, as well as the way of arguing about these consequences, will probably differ between these participants and students that are for example younger or attend other types of schools.

**Multiple framings of evidence**

With these focus group exercises it was possible to identify multiple types of framing of ‘evidence’ used by the participants. An interesting result of this study has been that in various respects, neuroimaging was argued by many participants to be no different than other forms of scientific evidence. As previously argued, it is often assumed that education practitioners have a purely positivistic attitude towards neuroimaging in particular. However, this exercise has turned out to be an interesting way of exploring ‘ground-level’ philosophy, as the different framings encountered in our analysis coincide with existing epistemological notions. Goldenberg (2006) draws on post-positivist, feminist and phenomenological philosophies of science to give new perspectives on evidence-based medicine, which is grounded in a positivist way of approaching knowledge. In the following paragraphs, we will demonstrate how these main lines of philosophical thought are clearly evident in the focus groups with regard to the evidence-base of neuroimaging.

Positive empiricists assume that there are ‘facts’ about the world and it is possible to know these facts. Many of the students, and some parents and teachers, framed evidence like this, and perceived neuroimaging as a tool to discover the ‘facts’ about the brain, which in turn is knowable (Goldenberg, 2006). These participants considered neuroimaging to be a technology that can provide evidence that is objective, tangible, visible and controllable, making it more reliable than non-scientific evidence, which was considered to be subjective, intangible, invisible and
uncontrollable. Considering the dualistic way in which knowledge is approached in (Dutch) secondary schools by placing emphasis on making a distinction between fact and fiction, it does not come as a surprise that most students use this conceptual schema. Different studies have shown that students develop these epistemological schemas during their transition to adulthood (see Hofer & Pintrich, 1997).

According to post-positivist theory, observations are always coloured by background beliefs and assumptions and any given body of evidence may support numerous, even contradicting theories (Goldenberg, 2006). A teacher interprets what is going on around him or her in interaction with the classroom, while a neuroimaging researcher interprets what is happening in the laboratory, in abstraction. Participants discussed the interpretations that scientists, using neuroimaging, had to make during their research, and also questioned how neuroimaging findings should be translated into educational practice, as in practice these findings could be interpreted in different ways, leading to different applications. The context of application was argued to be different in each classroom, for all teachers and for all children, and most certainly in regard to the context of research. For these participants, evidence does not prove a fact is out there, but rather is viewed as another type of interpretation. Interestingly, post-positivist thinking was more prominent during discussions in relation to psychological research in general than in regard to neuroimaging research. Neuroimaging research was regularly perceived to be an instrument that made research less subject to interpretation, rather than a tool of interpretation. Previous experience with evidence has shown to be a factor in this post-positivist thinking, as evidence for certain measures is not always automatically trusted in light of past (failed) reform. This influence was also shown by Coburn et al. (2006), in their study how administrators make sense of evidence in school districts.

Feminist philosophers of science go one step further and challenge the notion of the knower being unattached to the subject that is known, arguing that there is no such thing as an autonomous, objective researcher (Goldenberg, 2006). Feminist epistemologies are especially resistant to the idea that the experience of inquiry would be shared if research circumstances were to be ideal for all parties, were it not for bias or error. Rather, feminists argue that “objectivity” and “universality” are constructs obstructing subjective elements of research (Goldenberg, 2006). During the focus groups, participants did not so much argue that the scientific experience of
researchers themselves was not generalizable, but participants did make objections to the reinforcement of stereotypes or labels occurring when neuroimaging is used to gain insight into the differences between groups. They argued that when technology is used to compare girls and boys for example, emphasis is put on the neurological differences between these groups. In addition, many participants objected to the idea that neuroscience could lead to universal knowledge.

A phenomenological way of approaching evidence was also seen quite frequently in the focus groups. This approach to science challenges the idea that evidence should come primarily from objective measures (Goldenberg, 2006). Teachers and parents, in particular, stressed the importance of their own subjective, embodied experience as being a valid form of knowledge. Considerable frustration was encountered regarding new teaching policies that did not fit within their own teaching framework and comfort zone.

Naturally, the variety in ways of framing the application of neuroimaging within the domain of education doesn’t end here, with different conceptions of evidence, but extends to many other elements of education and (neuro)science. Howard Jones (2008) has compared the way in which neuroscientists and teachers understand ‘learning’ and demonstrates that the educational view on learning places more emphasis on the social construction of knowledge, learning within groups and communities, and the importance of providing context to what is taught. These results are similar to the empirical results presented in this article. Howard Jones relates this difference to conceptions of the brain-mind relationship (monism/dualism), which is indeed a very interesting issue, but not a theme that arose from our empirical research. In addition, participants held different views of the importance of evidence-based education, relating to their framing of the function of school and education in society, the approach, role and responsibility of teachers, students, and parents, and also to their framing of ‘learning’.

What’s next?

In a society that demands more accountability from science and increasingly contests scientific and technological expertise, there is a need for more socially robust knowledge that takes into account the practice in which it is embedded (Nowotny, 1999). For many participants, it was not a question of applying either neuroimaging
evidence, or psychological research, or the teacher’s or student’s subjective interpretation to education, but of whether or not this knowledge fits within current practice and is in line with their values. Neuroscientific evidence was not perceived to be a magic bullet, and as a measure to guard against negating the enormous amount of experiential knowledge already embedded in practice we feel this should and can be reflected more in research and education policy. The way end-users frame evidence actually conflicts to some extent with neuroscientists’ own positivistic framing of evidence-based education, as described in chapter six (Edelenbosch, forthcoming a). Neuroscientists, for example, frequently argue that neuroimaging findings need to be rigorously tested within the practice of education before they can be implemented. However, the everyday practice of education is often not conducive for the right conditions for this kind of quantitative research, many factors that are at play are difficult to control. Therefore, education policy should aim to be ‘evidence-informed’ rather than evidence-based, in line with Biesta (2007), and take as a starting point dialogue with stakeholders from both science and society about how scientific research can positively influence education. With regard to the application of neuroimaging to education we have uncovered a polarized, black-and-white debate, in which both research and practice are perceived as being positivistic. To create room for constructive dialogue about how neuroscience can positively influence education, it is necessary that the many ways in which people from both science and practice frame ‘evidence’ is taken into account.