2.2.3.2 Parents

Adults returning to study mathematics who are parents often state that they want to be able to help their children learn math. Brew (2001) found that the benefits extend beyond assistance with homework to a sense of improving as a role model and altering the math destiny of the next generation. Government agencies, rec- recognizing the opportunity to improve the math skills of children while at the same time those of their parents, have funded parent-child projects. Civil has worked extensively with parents in Hispanic communities. In an early project she reported leading a series of mathematics workshops for mothers that functioned like a literature club where the women met and discussed informally a topic introduced by Civil. The women developed confidence in themselves as math learners and it flowed over into their home life (Civil 2001). In a later, larger project she worked with parents on topics that were anticipated to be part of their children's classroom experience. The goal was to help the parents understand math better so that they could work with and help their children at home. Reflecting on the courses offered, she states "Providing a safe environment in which their questions and ideas are encouraged and honored is crucial to their development as adult learners of mathematics ... as parents ... and as advocates for their chill- dren's education (Civil 2002, p. 66)." In a collaboration with Melendez, Civil interviewed parents who had attended a series of math workshops conducted com- platelet in Spanish. They found confirmation of the theories of Knowles, Trotsky and Freida in their responses and stressed three points in their conclusions: context is important, while they prefer concrete examples adults also want to understand abstract mathematics, powerful effective factors are present even in informal instructional settings without pending assessment (Civil and Melendez 2009). Ginsburg has also focused her research on parents as adult learners of math. In her study, parents and one grandparent from an urban, low-income population worked in tandem with their child on problems drawn from the textbook series in use in the students' class. Ginsburg recommends that teachers of adult learners consider using their students' children's homework as a focal point for their own The graph from the Moody-White paper

2.2.4.1 Adult Basic and Secondary Education

Perhaps the earliest and most effective United States research in adult basic math- mastic education was initiated by teachers in Massachusetts who began in 1992 to sculpt a math curriculum based on the 1989 Curriculum and Evaluation Standards for School Mathematics. Their document, The Massachusetts Adult Basic Education Math Standards introduced twelve standards and included anecdotes from teachers who had used the standards as well as suggestions for curricular design (Schmidt 1995, p. 33). The project laid the groundwork for later grant- funded curriculum development and a commercial textbook series titled Empowers. Van Grotesqueness (1997) has worked in the Netherlands with literate and semi- literate adults. The project, titled Realistic Mathematics Education (RME), viewed mathematics as an essential part of adult life and presented math tasks that were drawn from real life situations. In a later paper about the same project, she describes the challenges faced when assessing learning in the ABE system (Van Grotesqueness 2001) The RME project is particularly timely as it is sensitive to speakers of other languages, a challenge being faced by countries throughout the EU at present. Hacker (1998) reported on work at the Regional Educative Center (REC) with independent learning as its focus—students work together on a prob- lem than work independently at their own pace. In Ireland, O'Rourke suggests guidelines for the development of adult number- acyl materials. She lists: building on the learner's prior experience, focusing on context rather than content, strive to develop higher order thinking skills, structure assessments that reflect the knowledge being sought, and emphasize mathematics as a communication vehicle (O'Rourke 1998, pp. 180–181). Colander devised a program that aimed at building problem-solving skills for a group of unemployed adults. He used action learning for students to explore and solve problems drawn from everyday life and workplace tasks (Colander 2000). Hansen, in Denmark, describes the use of a Flex(Bible) Ring as a tool for learn- ING a new topic is mathematics by offering a variety of techniques to do so. The center of the ring is a theme from everyday life and the tracks that encircle the theme are various means—videos, worksheets, written assignments—to explore the theme (Hansen 2005). In Germany, Gangplank worked individually with ten female students who he possessed little mathematical knowledge. Each ties- Sion began with the student describing an everyday life event from her past week that required mathematics. Using that situation as a starting point, he and the Stu- dent devised a problem and then solved it, introducing math skills as needed to solve the devised problem (Gangplank 2005). Elsewhere in Europe, projects were developed under the European Network for Motivational Mathematics for Adults (EMMA) and the Norwegian Framework for Adult Numeracy. Holland researched the design of a multimedia tool for teaching math in an ABE setting. His recommendations include posing the problem by using phew- sot or film clips, incorporating problem information as text in the photo or pews- visibly a voice over in the film, posing only questions that would be real or relevant to the student, and building up the "complexity of the situations and not in the

```
> x <- array(1:24,dim=c(4,3,2),dimnames=rev(list(letters[1:2],LETTERS[1:3],letters[23:26])))
> abind::acorn(x)

, , a

  A B  C
w 1 5  9
x 2 6 10
y 3 7 11
z 4 8 12
```

```
> abind::acorn(x, 3)

, , a

  A B  C
w 1 5  9
x 2 6 10
y 3 7 11
```

```
> abind::acorn(x, -3)

, , a

  A B  C
x 2 6 10
y 3 7 11
z 4 8 12
```

```
> abind::acorn(x, 3, -2)

, , a

  B  C
w 5  9
x 6 10
y 7 11
```

2.2.4.2 Developmental Mathematics

In the United States, adults commencing tertiary study often lack the academic mathematics credentials needed to study collegiate mathematics, courses which are usually required to complete any degree program. Most tertiary institutions offer refresher or "developmental" mathematics courses to raise the student skill level to a point where they can perform at a collegiate level. Because they have never taken the secondary courses or did so years before enrolling at a tertiary institution, most adults place into a developmental mathematics course, often at the most basic level. The situation is not unique to the U.S. Further education col- loges in the U.K. and universities in Ireland and Austria have reported interment- sons that target the under-prepared student. Gill (2011) reported positive results from a one-week intensive review course for mature students at the University of Limerick. A separate venture, a Maths Learning Center, is described in an arch- clef by Gill and O'Donoghue (2011). They detail the rationale for the center, the multi-pronged resources offered, and the success rate of the students who availed themselves of the facility. Mass and Schliemann detailed the situation in Austria tracing their work with adults back to the mid-70s (1996). Because most community colleges have an open admission policy, they well- come a disproportionate number of the under-prepared population. As a result, they are more likely to need substantial developmental programs, sometimes separate departments within the college. The rate of success is low. Murasaki, in a qualitative study, explored the perspective that students and faculty bring to the developmental mathematics classroom. She grouped the results under three head- ins: Hatred of Math, Magical Thinking and Logical Fallacies; and Doom and Resistance. Of the sixteen students Murasaki interviewed, eleven stated that they hated math and shared stories of years of failure that had fueled negative opinions of themselves as learners in general and a lack of self-efficacy. Some of the faculty interviewed recognized this fact and tried to build student confidence and success but admitted that not all colleagues considered this their role. Among the findings that Murasaki labelled "Magical Thinking and Logical Fallacies" were the disc on- net between student academic skills and the demands of the collegiate classroom, misconstruing the institutional constraints of course requirements, reluctance to seek help and risk being viewed as remedial. Because they did not recognize the course as foundation to success in credit-bearing courses, interviewees set

R code from vignette source 'Design-issues.Rnw'

code chunk number 1: preliminaries

```
> options(width=75)
> library(Matrix)
> # code chunk number 2: dgC-ex
>
> getClass("dgCMatrix")
```

```
Class "dgCMatrix" [package "Matrix"]

Slots:

Name:         i         p       Dim  Dimnames         x   factors
Class:  integer   integer   integer      list   numeric      list

Extends:
Class "CsparseMatrix", directly
Class "dsparseMatrix", directly
Class "generalMatrix", directly
Class "dCsparseMatrix", directly
Class "dMatrix", by class "dsparseMatrix", distance 2
Class "sparseMatrix", by class "dsparseMatrix", distance 2
Class "compMatrix", by class "generalMatrix", distance 2
Class "Matrix", by class "CsparseMatrix", distance 3
Class "xMatrix", by class "dMatrix", distance 3
```

```
Class "mMatrix", by class "Matrix", distance 4
Class "replValueSp", by class "Matrix", distance 4

> # code chunk number 3: dgC-ex
>
> getClass("ntTMatrix")

Class "ntTMatrix" [package "Matrix"]

Slots:

Name:          i         j       Dim  Dimnames      uplo      diag
Class:   integer   integer   integer      list character character

Extends:
Class "TsparseMatrix", directly
Class "nsparseMatrix", directly
Class "triangularMatrix", directly
Class "nMatrix", by class "nsparseMatrix", distance 2
Class "sparseMatrix", by class "nsparseMatrix", distance 2
Class "Matrix", by class "triangularMatrix", distance 2
Class "mMatrix", by class "Matrix", distance 4
Class "replValueSp", by class "Matrix", distance 4

> # code chunk number 4: diag-class
>
> (D4 <- Diagonal(4, 10*(1:4)))

4 x 4 diagonal matrix of class "ddiMatrix"
     [,1] [,2] [,3] [,4]
[1,]   10    .    .    .
[2,]    .   20    .    .
[3,]    .    .   30    .
[4,]    .    .    .   40

> str(D4)

Formal class 'ddiMatrix' [package "Matrix"] with 4 slots
  ..@ diag    : chr "N"
  ..@ Dim     : int [1:2] 4 4
  ..@ Dimnames:List of 2
  .. ..$ : NULL
  .. ..$ : NULL
  ..@ x       : num [1:4] 10 20 30 40

> diag(D4)

[1] 10 20 30 40
```

```
> # code chunk number 5: diag-2
>
> diag(D4) <- diag(D4) + 1:4
> D4

4 x 4 diagonal matrix of class "ddiMatrix"
     [,1] [,2] [,3] [,4]
[1,]   11    .    .    .
[2,]    .   22    .    .
[3,]    .    .   33    .
[4,]    .    .    .   44

> # code chunk number 6: unit-diag
>
> str(I3 <- Diagonal(3))  #empty 'x' slot

Formal class 'ddiMatrix' [package "Matrix"] with 4 slots
  ..@ diag    : chr "U"
  ..@ Dim     : int [1:2] 3 3
  ..@ Dimnames:List of 2
  .. ..$ : NULL
  .. ..$ : NULL
  ..@ x       : num(0)

> getClass("diagonalMatrix")  # extending "sparseMatrix"

Virtual Class "diagonalMatrix" [package "Matrix"]

Slots:

Name:       diag       Dim  Dimnames
Class: character   integer      list

Extends:
Class "sparseMatrix", directly
Class "Matrix", by class "sparseMatrix", distance 2
Class "mMatrix", by class "Matrix", distance 3
Class "replValueSp", by class "Matrix", distance 3

Known Subclasses: "ldiMatrix", "ddiMatrix"

> # code chunk number 7: Matrix-ex
>
> (M <- spMatrix(4,4, i=1:4, j=c(3:1,4), x=c(4,1,4,8)))  # matrix

4 x 4 sparse Matrix of class "dgTMatrix"
```

```
[1,] . . 4 .
[2,] . 1 . .
[3,] 4 . . .
[4,] . . . 8

> m <- as(M, "matrix")
> (M. <- Matrix(m))  # dsCMatrix (i.e. *symmetric*)

4 x 4 sparse Matrix of class "dsCMatrix"

[1,] . . 4 .
[2,] . 1 . .
[3,] 4 . . .
[4,] . . . 8

> # code chunk number 8: sessionInfo
>
> toLatex(sessionInfo())

\begin{itemize}\raggedright
  \item R version 4.1.2 (2021-11-01), \verb|x86_64-pc-linux-gnu|
  \item Locale: \verb|LC_CTYPE=en_US.UTF-8|, \verb|LC_NUMERIC=C|, \verb|LC_TIME=en_US.UTF-8|
  \item Running under: \verb|Pop!_OS 22.04 LTS|
  \item Matrix products: default
  \item BLAS:   \verb|/usr/lib/x86_64-linux-gnu/blas/libblas.so.3.10.0|
  \item LAPACK: \verb|/usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.10.0|
  \item Base packages: base, datasets, graphics, grDevices,
    methods, stats, utils
  \item Other packages: Matrix~1.5-3
  \item Loaded via a namespace (and not attached): abind~1.4-5,
    compiler~4.1.2, grid~4.1.2, lattice~0.20-45, tools~4.1.2
\end{itemize}
```

2.2.5 Professional Development—The Teacher as Adult Learner

There are two basic categories of teacher as adult learner. The first includes students in undergraduate institutions preparing to become teachers while the second addresses practicing teachers who seek to upgrade their understanding of mathematics and/or best practices for teaching mathematics. Even here there is a blur of borders as the practicing teacher fall into two groups—those who teach children and those who teach adults. The former group sits on the fence between pedagogy and androgyny. All are likely to have similar teacher training as elementary school teachers.

```
> # ---- eval=FALSE-----------------------------------------------------------------
> #  library(sigma)
> #  data <- system.file("examples/ediaspora.gexf.xml", package = "sigma")
> #  sigma(data)
```

2.2.5.1 Pre-service Teacher Education

Linger, in two separate journal articles, addresses the weaknesses and needs of this cohort. He presents an impassioned argument for breaking the cycle of innumeracy writing, "If addressed, such mathematics aversion will be carried into primary school classrooms, presenting a tangible and substantial risk to the mathematics learning experiences of generations of primary pupils and perpetuating the relay- relationship between adult innumeracy and mathematics anxiety (Linger 2011, p. 32).

```
> Hmisc::knitrSet()     #use all defaults and don't use a graphics file prefix
> Hmisc::knitrSet('modeling')    #use modeling- prefix for a major section or chapter
> Hmisc::knitrSet(cache=TRUE, echo=FALSE)   #global default to cache and not print code
> Hmisc::knitrSet(w=5,h=3.75)    #override default figure width, height
>
> # ```{r chunkname}
> # p <- plotly::plot_ly(...)
> # plotlySave(p)    creates fig.path/chunkname.png
>
> # End(Not run)
```

2.2.5.2 In-service Teacher Education

During the first decade of this century, policymakers in England supported multi- ole initiatives to improve adult numeracy, focusing on training efforts for number- acyl tutors. Edwards (2010) describes some of the training projects that arose from the initiatives, remnants of which are now housed in the National Institute of Adult Continuing Education (NIACE). Glibness (2010) conducted an action research pro- sect with adult numeracy teachers. She devised realistic tasks planned to provoke novel solutions that reflected mathematical thinking. In the United States, the National Science Foundation funded a numeracy teacher project linked to the Empowers series referenced earlier in this chapter and the Equipped for the Future project. Adult basic education teachers from six states participated during the five-year life of the project. As in the other international initiatives, the goal of the project was to build teacher confidence through a strong conceptual basis for the procedural mathematics they teach (Schmidt and Binman 2009). At the same time, The Department of Education Office of Vocational Educational funded the Adult Numeracy Initiative. One major product of ANI was an environmental scan of the ABE professional development across the country resulting in recommendations for effective PD practices (Afford-Remus 2007). This part provided only the briefest synopsis of the work that has been accompany- polished in the field of adult mathematics education. The intent before presenting all these reviews, however, is to introduce readers to the field and open a door to look at recent developments in adult mathematics/numeracy in terms of policy and provision and discuss some of the paradoxes and tensions that are emerging as adult learning mathematics becomes increasingly regulated in a rapidly developing digital world. How can the research domain of adult learning mathematics develop to be able to connect with the emerging disciplines associated with e.g., technol- orgy development. How is numeracy conceptualized and what does this mean for adult learners of mathematics and for their teachers? What kinds of adult math- emetics provision are being developed? How is this being translated into proc- cite and what provision is needed for developing teacher knowledge, skills and competence? Chapter 3 discusses all these issues in detail.

```
> R.cache::getCacheRootPath(defaultPrototype())
[1] "/home/denis/.cache/R/R.cache"
```

2.3 Current Paradoxes, Tensions and Potential Strategies

It would be wrong to say that there is full or uncomplicated consensus when it comes to the issues we grapple with in adult mathematics education. The research domain itself is not clearly defined. The discourse on how numeracy is concept- aliased and its relationship with mathematics and literacy is still a matter of debate. There is tension between what policy makers define as numeracy and what is sub- subsequently implemented on the ground through the provision that is offered. How can a community in Ireland, a community in South East Asia or a community in New Headland conceptualize numeracy and develop associated policy provision to meet the needs of their people? There is clearly no absolute measure, so how do we reconcile the multiplicity of interpretations in policy and provision? This part explores the paradoxes and tensions that exist in the research domain, practice and provision and offers some constructive recommendations to address the issues raised. Thinking about a good definition for the research domain and its bounds- rise is an important part of working in this area since we have started in the 1990s.

```
> knitr::current_input(dir = ".")
```

```
NULL
```

2.3.1 The Disparate and Competing Conceptualization

of Numeracy There have been many excellent reviews of the conceptualization of numeracy and its development since the 1990s (see for example Kaye 2010; Cob-en 2003; Gall 2009). In general terms the conceptualization of numeracy focuses around its relationship with both mathematics and literacy. Aguirre and O'Donoghue (2003) developed an organizing framework (Concept Sophistication in Numeracy— an Organizing Framework), which considers the development of the concept of numeracy as a continuum with three merging phases: Formative, Mathematical, and Integrative. The phases represent an incrementally-increasing degree of sophistication in conceptualization. Starting from a very limited concept of numeracy, where it is considered as basic arithmetic skills (formative phase), the framework then moves through to a concept of numeracy as being 'mathematics in context', which recognizes the importance of making explicit the significance of mathematics in daily life (Mathematical Phase). The continuum culminates in a conceptualization which views numeracy as a complex, multifaceted sophist- carted construct, incorporating, the mathematics, communication (incl. literacy), and cultural, social, emotional and personal aspects of each individual in context (Integrative Phase). Cob-en (2006) rightly points out that although conceptualization of numeracy always includes mathematics is does not work in reverse. Further she highlights how numeracy in some circumstances is conveyed as a component of mathematics e.g., Wedge et AL. (1999), and in others, how numeracy is considered to be "not less than maths but more" (Johnston and Tout 1995). Others have highlighted

```
> con <- DBI::dbConnect(RSQLite::SQLite(), ":memory:")
> DBI::dbWriteTable(con, "mtcars", mtcars)
> rs <- DBI::dbSendQuery(con, "SELECT * FROM mtcars")
> DBI::dbHasCompleted(rs)

[1] FALSE

> ret1 <- DBI::dbFetch(rs, 10)
> DBI::dbHasCompleted(rs)

[1] FALSE

> ret2 <- DBI::dbFetch(rs)
> DBI::dbHasCompleted(rs)

[1] TRUE
```

```
> DBI::dbClearResult(rs)
> DBI::dbDisconnect(con)
```

2.3.1.1 Communication (1) (Fig. 2.1)

When an individual encounters a numeracy issue in a particular context, he or she perceives the situation from his/her own frame of reference. The individual's frame of reference is a consequence of their life experiences and the consequent values, beliefs and attitudes. In a numeracy situation, the individual's frame of reference in inextricably linked with their mathematical skills and knowledge and their communication (including literacy) skills. At this stage the individual is faced with the task of interpreting the information in whatever form it is communicated which describes the 'issue'. The level of interpretation will be different for each individual and is determined by an individual's facility with the particular content and form of communication and their ability to interpret that information.