DECOLONIZING EDUCATIONAL DESIGN FOR SCHOOL MATHEMATICS

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There are currently increasingly frequent calls to *decolonize* various aspects of our education systems, particularly at university level. However, we are yet to see anything like the same level of focus on decolonization within the *school* curriculum (*i.e.,* education up to an age of around 18). Progress is being made (*e.g.,* Ellerton & Clements, 2008), and the current renewed emphasis on curriculum in some parts of the world may present opportunities to progress this agenda (see, *e.g.,* Foster, Francome, Hewitt & Shore, 2021). It is important to note that many countries in the global south, often with long histories of coloniality embedded within their school systems, have been seeking to address decolonization for a long time. Examples include developing language of instruction policies that focus on teaching in Indigenous languages and degrees for future teachers that are focused on topics such as rural education.

Within higher education, decolonization has almost exclusively targeted the arts, social sciences, humanities and medical disciplines. We have seen concern expressed, for example, about the eurocentric nature of the history curriculum, and of the canon of novels studied in literature. More broadly, the scarcity of authors from the global south within reading lists has been a dominant theme. However, less attention has been given to STEM subjects generally, and mathematics in particular [1]. It is naturally easier to see what might be entailed in decolonizing arts and humanities disciplines. For example, if most of the novels students are reading in English are written by white, male, european authors, then the problem is clear, and so is the solution. Of course, this will meet resistance, and will entail considerable time and effort for teachers or lecturers to gain familiarity with a more diverse canon of literature, and devise appropriate ways to teach it, but what needs to be done is not hard to see. However, it may be harder to identify what exactly the problem is in mathematics, particularly within the purer aspects of the subject, as so often mathematics is construed as an acultural and apolitical object (see Gerdes, 1994).

The present article brings together five authors, one each from Brazil, Indonesia, Turkey, Uganda and the UK, in an attempt to develop discussions about decolonization within school mathematics, taking the particular focus of *mathematics educational design.* We recognize the importance of considering decolonization of school mathematics broadly, taking account of curriculum, pedagogy and assessment, as well as other aspects, but we choose to root the discussion here in educational design in mathematics in particular. We do this in order to draw on our own interest and expertise in educational design, which is an area which a recent *FLM* article foregrounded as of growing importance (Sümmermann & Rott, 2020).

All of the authors are experienced designers and users of educational resources for the school mathematics classroom, and our varied research interests focus in depth on school mathematics classrooms and the teaching and learning that takes place there. While we all bring different lived experiences to our understandings of these issues, we choose to speak as a group, rather than individually, about actions that we think could be productive for educational design within mathematics to consider in order to take the necessary next steps to address more substantially the challenge of decolonization.

Beyond the differences in the countries in which we were born and now work, we recognize that we all bring complex constellations of privilege and unprivilege to our perspectives. All of us have experienced some of our education in the global north and we are all fluent in speaking and writing English. Some of us might describe ourselves as occupying the 'middle class' in our different settings. Certainly, we do not see ourselves as speaking 'for' any group or groups. In this article, we use the terms global north/south and west/non-west interchangeably and with caution, recognising their inadequacy for capturing important distinctions (for a discussion, see Moosavi, 2020, p. 345). For instance, Latin America may be regarded as south, but also west, and parts of Asia, such as Japan, may be seen as non-western but nonetheless part of the global north. Throughout, we avoid capitalizing words like 'north' and 'european' that might contribute to reinforcing hierarchies of importance associated with those regions.

In this article, we first set out how we conceptualize the challenge of decolonization of educational design within mathematics before outlining what we term 'multicultural responses'—valuable, but taking us only so far. We then go on to explore what we see as deeper and more demanding 'decolonizing responses' that address structural aspects of decolonizing educational design within mathematics that we believe are essential to meet this challenge.

Understandings of decolonization for educational design

The idea of decolonization goes back many decades, and, as one might expect, originates within the global south (see Moosavi, 2020). It is important to recognize these origins, since it has been pointed out that an 'intellectual' version of

decolonization has become hijacked by scholars in the north, risking erasing or sidelining the important work of scholars of color (Manthalu & Waghid, 2019; Moosavi, 2020). Well-known examples of southern scholars with major contributions in this area are Frantz Fanon, Edward Said and Ubiratan d'Ambrosio; other less well-known but important authors are Claude Ake, Syed Farid Alatas and Ngg wa Thiong'o (see Moosavi, 2020, for a discussion).

According to the 'Keele manifesto for decolonizing the curriculum' [2]:

> Decolonization involves identifying colonial systems, structures and relationships, and working to challenge those systems. It is not "integration" or simply the token inclusion of the intellectual achievements of non-white cultures. Rather, it involves a paradigm shift from a culture of exclusion and denial to the making of space for other political philosophies and knowledge systems. It's a culture shift to think more widely about why common knowledge is what it is, and in so doing adjusting cultural perceptions and power relations in real and significant ways. (n.p.)

We see coloniality as capturing the multitude of ways in which colonial injustices continue to be perpetuated within our world, and within educational systems and structures in particular, including in educational design. Coloniality is structural and systemic, going well beyond the actions of particular individuals, and is fundamentally a widespread and deeply-rooted set of injustices which are socially reproduced over time. The cultural shift towards decolonization is a considerable intellectual, social, cultural, personal and emotional challenge, and cannot be made without sustained thought and commitment.

Tuck and Yang (2012) argued that decolonization is not a metaphor, but an unsettling perspective, geared towards making structural changes in society. For many people across the world, mathematics is more than a school subject: it is a gateway to studying and working within STEM employment, and to the financial security derived from that. Decolonizing the design of school mathematics involves addressing injustices that perpetuate inequalities within the world, leading to structural changes in societies.

Educational designers, especially for a compulsory and high-status school subject like mathematics, are in a powerful and privileged position. Textbook authors and others who design resources for use in the mathematics classroom have, like teachers, direct access into young people's lives, and this comes with the opportunity to influence and promote ideas and enhance or diminish young people's futures. The contents of classroom resources constrain not only the students but also the teacher, strongly influencing and even determining how mathematics content is presented and taught, the questions and tasks that are asked and not asked, and the patterns of critical discourse that are encouraged or not encouraged. We see *decolonizing mathematics educational design* as an attempt to disrupt the way in which predominantly white, european mathematics task designers have tended to reproduce the knowledge, values, patterns of engagement and overall view of the subject that they themselves have acquired, and succeeded within, in a colonial system, and which supports the *status quo* of existing power structures and inequities.

Multicultural responses to the challenge

Decolonizing is a process, and this article is not starting from the beginning. Over recent decades, progress has been made within mathematics educational design. We use the term 'multicultural responses' to capture attempts at being more inclusive and equitable, and we see these as important, although limited. For example, diverse clipart and stock photographs are now cheaply and easily available, and there is now no excuse for any educational designer to fail to include faces and hands and hairstyles that are representative of a broad cross-section of people. While past authors might have needed a reference book of 'multicultural names' if they wanted to add variety to the scenarios in their mathematics tasks, nowadays the internet makes this trivially easy. However, while playing an important role in shifting attitudes, and allowing marginalized students to see characters on the page that they might identify with more easily, these changes are essentially superficial when set against the terms of the 'Keele manifesto' statement given above.

A step beyond 'names, faces, hands and hair' is to focus attention on the history of mathematics and broaden the knowledge base of stories of 'great mathematicians' beyond the traditional white, male europeans, such as Gauss summing the integers and Galois fighting a duel. By doing so, we can instead center and validate the mathematics of a much more diverse range of people from a variety of cultures, including the global south, to include figures such as Muammad ibn Ms al-Khwrizm (see, *e.g.,* Robson, 2008). Related to this are attempts to challenge colonial namings, such as 'Pascal's triangle' (how did it become 'his', given that it was known thousands of years earlier in China?). Even more problematic instances include objects such as 'Pearson's correlation coefficient', given Karl Pearson's enthusiastic support for racist and eugenicist views. It can be a challenging problem to solve, because, in many cases, the contributions of great mathematicians in the south are not documented as systematically as are those from within europe. However, it is possible—and important—to reference countries, cultures and cultural groups which were critical to the development of mathematics, such as our number system, which derives from a combination of Arabic and Indian contributions. Rethinking terminology that centers colonizers and oppressors, exposing the background behind commonly-used namings, and adopting more just naming practices, are all ways to support a more multicultural perspective on the historical development of mathematics.

However, while we see such steps as necessary and important, the history of mathematics continues to be a marginalized aspect of the mathematics curriculum, at university level, as well as at school. Unlike a subject such as music, which cannot be studied at any level without serious attention to its history, mathematics continues often to be presented largely as if it were an acultural and ahistorical enterprise (see Gerdes, 1994). Historical anecdotes in school mathematics resources are likely to be brief, low-status 'asides', used perhaps to fill a bit of empty space on the

page, and intended largely for amusement or motivational purposes. Even if all eurocentric historical references were replaced overnight by empowering stories of mathematicians of color, the overall impact on students' experience of the mathematics curriculum would likely be very small. To focus our diversifying efforts on the history and nomenclature of mathematics would appear to risk inadvertently marginalizing diversity yet again.

A further step beyond decolonizing the history of mathematics is the attempt to deploy traditional ethnic contexts and artefacts within the teaching of mathematics. The most common examples seem to be Islamic art, Rangoli and Sona patterns, Batik fabrics, Tatami mats, Mayan astronomy and traditional games with stones or seeds. The tradition of ethnomathematics (D'Ambrosio, 1985) offers us rich sources of such materials, which can be highly engaging for students, and offer opportunities to center non-western mathematics. These can be very positive moves and can be powerfully affirming for students of color. However, in our experience, such activities tend to appear rarely in the classroom, and often at low-status times within the school year, such as in connection with well-defined events, such as Black History Month, or at the end of the week, or the end of the school year, after important summative assessments are completed. This can have a tokenistic effect, which marginalizes such activities as 'fun math' in distinction to 'proper math' that will be assessed and *really* counts.

A further danger here is of western educational designers engaging in the practice of *cultural appropriation,* in which an un-diverse team of authors, lacking any lived experience of the relevant culture, simply searches for 'ethnomathematical' ideas on the internet or in research papers, and then applies—or, perhaps, misapplies—them in the resources that they design. While this may be well-intended, it is reminiscent, particularly where resources are commercially produced and sold, of white businesspeople profiting from setting up ethnic food shops on the high street. Moosavi (2020) criticized the

> eagerness to incorporate marginalised perspectives or people […] in ways that reinscribe coloniality […] through the essentialisation or appropriation of people, ideas or culture from the Global South in a manner that imitates what occurred at the height of colonialism. (p. 343)

What we might call 'context looting' or 'task looting' "may appear innocent and even affirming to the one doing the appropriating, but […] may actually be more exploitative than is first realised" (p. 344). We now suggest below some ways to move beyond some of these limited and potentially problematic responses that are 'merely' multicultural.

Decolonizing responses to the challenge

We do not wish to be misunderstood as criticizing the value of the 'multicultural responses' that we have outlined above. We wish to reiterate that we regard them as valuable and a necessary part of the solution. However, we feel that they only *begin* to address what is needed.

A common thread within the 'multicultural responses' is that they are concrete, relatively low cost, and quick and fairly easy to implement, at least in the limited ways that we have described. And, while these features might seem attractive to the busy educational designer, we recognize that easy solutions are not always optimal or sufficient. Martin (2009) reflected on presenting workshops on his research on mathematics education and race, and on how often people asked for *immediate* takeaways that they could act on in response. While this might seem like a positive reaction to obtain—after all, they want to change their practice—he noted that "demanding an immediate and simple solution […] can […] be seen as a strategy used to hastily get past discussions of race and racism" (Martin, 2009, p. 304). We recognize this motivation and created the image in Figure 1 to represent this desire to find something actionable, and with low emotional cost—something to make the problem of decolonizing educational design go away—in this case, reducing it to the performative level of something like remembering to do a spellcheck on completion of a piece of educational design.

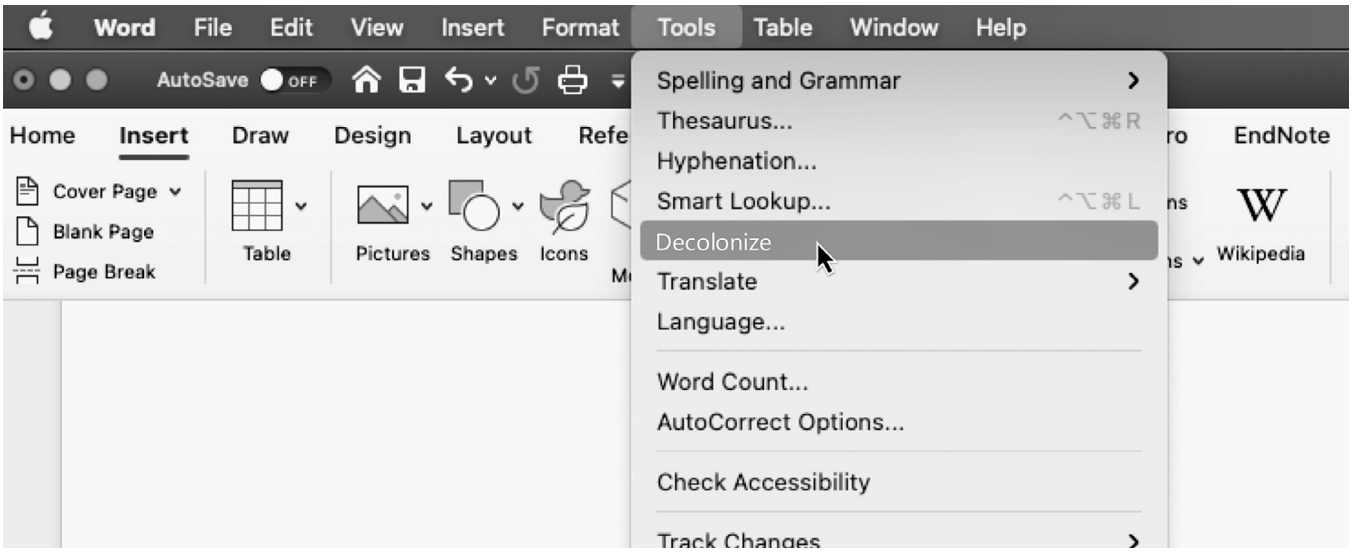

Figure 1. We intend this image as a provocative characterization of the desire for a simplistic, quick and ultimately dismissive approach to 'decolonizing educational design'.

Recognizing that the field of mathematics education operates as a "white institutional space" (Martin, 2013), we highlight here the danger of seeking an approach to decolonization that is above all else palatable to the dominant white majority (Martin, 2009; Tuck & Yang, 2012). The 'multicultural responses' outlined above are probably not particularly challenging to most liberal educators or teachers, other than through the possible inconvenience of having to think a little more and learn a small amount of new information. Designers from the global north who do these things are likely to receive praise and be perceived as virtuous for it. However, a deeper engagement with decolonization might threaten white privilege to a much greater degree and make more severe demands on time, energies and emotions, forcing us to rethink things that we had previously taken for granted.

Within the field of mathematics education, we do not lack examples of anti-racist teaching, which draw on critical race theory or ethnomathematics in ways that avoid essentialist views of students and that expose the socio-cultural-historical determinants of mathematics (*i.e.,* where it came from, when, by whom—and to whose advantage it now operates). We see examples of deep engagement with marginalized communities that go beyond traditional content to consider "what mathematical thinking is, what kinds of problems can (or cannot) be addressed with mathematics, and what is meant by the kind of treatment that mathematics gives to problems" (Parra & Trinick, 2018, p. 247), valuing Indigenous cultures and their mathematics and working with students, including in out-of-school settings. For example, in a recent *FLM* article (Ruef & Jacob, 2021), Indigenous authors reflected on decolonization enacted in the context of learning fractions by "centering Indigenous ways of being, knowing, and doing, in service of teaching and learning mathematics" (p. 17).

These approaches are developed and reported through research studies presented in the mathematics education literature, but do not necessarily inform mainstream work within educational design in mathematics. Educational design in mathematics needs to learn from and embed ways in which mathematics teaching can draw on pedagogies that engage students in culturally responsive environments, critically addressing and challenging the world through meaningful and relevant tasks and contexts that facilitate communities in resistance to social, political and economic injustices. Martin (2009) draws attention to how:

> Issues of design […] become centrally important as we consider how to engineer—at the everyday level and structurally—learning experiences that help students construct identities as doers of mathematics early in their school experiences, early enough to resist and challenge negative messages about race and ability that would otherwise become internalized. (p. 328)

For this to happen, it is not enough that educational designers scrutinize the resources that they design for any overt instances of unintentional 'colonialism' that may have 'slipped through' (the 'Decolonize' button in Figure 1). The problem resides not only in manifest features of 'the product' but also in 'the process' by which it was created. An un-diverse design team is already problematic even before they begin work, and to truly decolonize educational design we need to face this.

The Indigenous African [3] philosophy of *Ubuntu* is a humanistic framework that may provide an approach to working within communities of color so as to foreground decolonization (Seehawer, 2018). According to Oviawe (2016):

> *Ubuntu* is a philosophy of being that locates identity and meaning-making within a collective approach as opposed to an individualistic one. As a result, the individual is not independent of the collective; rather, the relationship between a person and her/his community is reciprocal, interdependent and mutually beneficial. (p. 3)

To take such an approach seriously, so as to embed it structurally within educational design, would entail western educational designers taking the initiative to build meaningful, ongoing, mutually-respectful and deliberately inclusive relationships with communities of color, and through this to learn what decolonizing design could mean in practice. Some of us perceive a lack of openness among europeans to understanding alternative ways of approaching the world, such as misperceiving a student from a culture that values respecting authority in a negative way as being 'passive' and 'not critical'.

Task designers in the north could actively build relationships that center teachers of color in mainstream schools, or in grassroots community 'Saturday schools', which are focused on the needs of marginalized students, through developing an empowering curriculum, with teachers as collaborative partners and mathematics task co-creators (see Wright, 2020). This could involve students and their families voicing their perspectives on school and mathematics, how existing educational design works, or does not work, for them, and what changes to established practices might improve the situation. Such conversations would need to extend beyond the 'multicultural responses' mentioned above, and into more fundamental features of educational design. These include the kinds of mathematics tasks that are posed, the enactment of the tasks, assessment tasks and practices, the language used to frame them, the ways in which designers envisage students engaging with them, and obstacles to students' participation and success with these—things that may be easily overlooked by western designers.

Importantly, at the same time as this, we need to address the predominance of white designers within the system by instigating mechanisms to support and nurture aspiring and existing designers within a diverse array of communities, especially within the global south. Recognizing the barriers to participation within an international community of educational designers means facing up to time and financial constraints operating in resource-poor settings, as well as the training needs of early-career designers. Organizations such as the International Society for Design and Development in Education could have a key role to play here [4].

In many parts of the global south, huge educational conglomerates currently exercise considerable power, exporting books and ready-to-use curricula to schools, universities

and, sometimes, governments. In both Brazil and Turkey, reforms have opened up space for 'innovative' companies to sell their products [5]. In Brazil, although such practices are progressing from local to wider contexts, this process does not seem to be the result of carefully considering its merits (de Freitas, 2014).

A further important feature within the design of mathematics teaching materials is the impact of the language of instruction. Language is not neutral, and indeed contains colonizing concepts, values, ideas and patterns of engagement and interaction that perpetuate discourses of coloniality. In Uganda, Kenya, Tanzania and now also Rwanda, the language of instruction in primary, secondary and post-secondary education is English. While Uganda has 63 ethnic languages, the language of instruction, interaction and resources in mathematics classrooms remains English, which is neither the first nor the second language of the learners. The fact that learners' indigenous languages are rarely considered as a medium of instruction or as a resource in mathematics classrooms substantively affects the nature of classroom interactions and the quality of teaching and learning in mathematics (Halai & Karuku, 2013). High-stakes school leaving examinations are also set in English, as are other literacy-focused examinations, such as the Uganda National Assessment of Progress in Education (NAPE), as well as regional assessments, such as the Southern African Consortium for Monitoring Educational Quality (SACMEQ) in Kenya, Rwanda, Tanzania and Uganda. This means that many learners are not able to evidence their learning effectively in school-leaving examinations.

Conclusion

We mentioned earlier how Sümmermann and Rott (2020) noted in their recent article in *FLM* that design in mathematics education is an area of growing importance. However, if decolonization within mathematics education design is to be taken seriously, then it is essential for every educational designer in the west to have a deep understanding of colonialism, whiteness and white privilege, and their effects within racialized spaces (Bhopal, 2020). Adopting a color-blind approach fails to do this (Crenshaw, 2019), and educational design which ignores the racialized nature of schools and classrooms, far from being in any sense 'neutral', is instead part of the problem (see Kendi, 2019).

We have suggested that the 'multicultural' responses to calls to decolonize mathematics education design, while important, are insufficient for disrupting the dominant, eurocentric epistemological default. Extending the focus beyond matters such as equality of representation in images, names, history and contexts, and into considerations of power and oppression, and how these work out at a deeper level, must be central to any discussion of decolonizing mathematics education design. This will risk the accusation "that one is bringing race into a situation or conversation where it previously did not exist and in which it does not belong" (Lewis, 2004, p. 635). However, we feel that it is every designer's responsibility to take seriously the challenge of classrooms as racialized spaces.

We believe that a truly decolonized mathematics education design could be visible on every page of a resource, and permeate both the big-picture and the fine details within each mathematics activity. This could be equally true for the design of individual mathematics tasks as for approaches focused on an entire set of curriculum resources. A truly decolonized mathematics curriculum must look fundamentally different, and will need to address central features of the ways in which mathematics is taught and learned in schools, the ways in which tasks are presented and assessed, and the ways in which ideas are questioned and discussed. What exactly this will look like we do not yet know—and we are not yet in a position to give examples—but an *Ubuntu* perspective on centering and collaborating with communities of color in this process offers an inclusive methodological way forward to building towards such an end.

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Notes

[1] According to K. Brodie in 'Yes, mathematics can be decolonised. Here's how to begin'. Online at https://theconversation.com/yes-mathematics-can-be-decolonised-heres-how-to-begin-65963

[2] Online at https://www.keele.ac.uk/equalitydiversity/equalityframeworksandactivities/equalityawardsandreports/equalityawards/raceequalitycharter/keeledecolonisingthecurriculumnetwork/#keele-manifesto-for-decolonising-the-curriculum

[3] *Ubuntu* is sometimes described as Southern African; however, it derives from Bantu-speaking people all over Africa. For instance, the Baganda people in Uganda are Bantu, and the word there for 'person' is *omuntu*.

[4] See https://www.isdde.org/2020-prizes-call-for-nominations for details of *The Bell Burkhardt Daro Shell Centre Awards for Aspiring Educational Designers in Science, Technology, Engineering or Mathematics,* a new annual award providing sums of US$1000 to encourage the work of aspiring educational designers in STEM focused on supporting learners from marginalized communities and/or their teachers.

[5] For example, in the Turkey Safe Schooling and Distance Education Project, commercial products will be used to support schooling during COVID lockdowns (see https://documents1.worldbank.org/curated/en/412291621264724229/pdf/Environmental-and-Social-Management-Framework-ESMF-Safe-Schooling-and-Distance-Education-Project-P173997.pdf). The products will be trialed in pilot schools, where teachers and students will give their comments, but not all countries have such a detailed piloting process.

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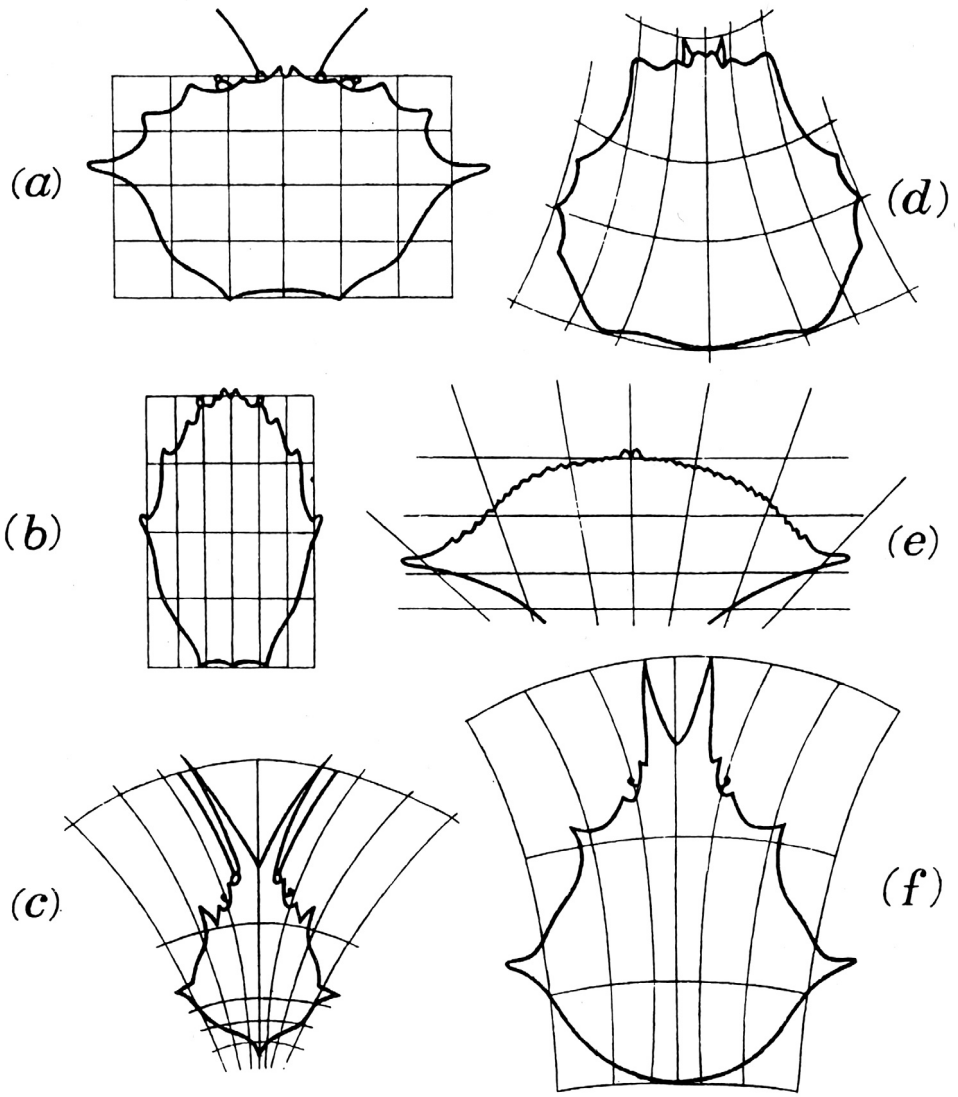

Fig. 142. Carapaces of various crabs. (*a*) *Geryon*; (*b*) *Corystes*; (*c*) *Scyramathia*; (*d*) *Paralomis*; (*e*) *Lupa*; (*f*) *Chorinus.*

—From 'On Growth and Form' by D'Arcy Wentworth Thompson