Exploring Price Conceptions as Part of Financial Numeracy

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This study investigates how third- and fourth-grade students conceive of prices and what challenges and potentials these conceptions present for the development of financial numeracy. Drawing on pre-intervention interviews from a Design-Based Research study aimed at fostering financial numeracy, students' explanations of price formation were analysed using qualitative content analysis. The findings show that many students initially interpret prices as objectively measurable quantities. At the same time, students were able to draw on diverse funds of knowledge when reasoning about pricing.

Introduction and Problem Statement

Financial competencies are widely recognised as essential in the 21st century, as they enable informed decision-making and resilience in an increasingly complex, and dynamic, financial landscape. Furthermore, research has demonstrated the central role of mathematics in financial decision-making, with large-scale studies showing strong positive correlations between mathematical and financial competencies (OECD, 2023). Despite this close connection, financial numeracy in school mathematics is often reduced to a narrow, basic-skills perspective rather than being viewed more broadly as a social practice. In primary classrooms, financial contexts frequently serve merely as artificial contexts for practising arithmetic procedures, rather than as authentic contexts that support students in making informed financial decisions (Savard et al., 2020). Such approaches risk obscuring the complexity of financial decisions, and limit students' opportunities to engage critically with financial situations. Broad definitions of financial numeracy (as suggested by Blue et al., 2018; and Savard & Cavalcante, 2021) emphasise that it should also support students in understanding financial concepts, such as prices, through mathematical investigation and in critically examining systemic implications, including the social and ethical consequences of financial decisions, such as pricing practices. This study explores how German primary school students conceive of prices and examines the challenges and potentials these conceptions pose for the development of financial numeracy.

Theoretical Background

Definition of Numeracy and Financial Numeracy

Numeracy definitions can be understood along a continuum, ranging from a narrow view of numeracy as a set of technical skills to a broader view of numeracy as a social practice. On the technical side, numeracy is viewed either procedurally, emphasising basic mathematical skills, or functionally, stressing its importance for personal well-being and economic productivity. On the social-practice side, numeracy is contextualised, focusing on its relevance across home, work, and civic settings. It also takes a critical perspective, emphasising how numeracy can help individuals interpret data responsibly and challenge social injustice (Goos & O'Sullivan, 2022). The "Numeracy in the 21st Century" model by Goos et al. (2020) reflects this broader view of numeracy and the dimensions it encompasses. It is not limited to mathematical knowledge but also includes dispositions, tools, and the sense-making of extra-mathematical contexts. These dimensions are embedded within a critical orientation, which involves using mathematics to make decisions, build arguments, and evaluate positions. A critical orientation also includes understanding how mathematics is used or misused in social contexts, enabling critical participation in public discourse (Goos et al., 2020).

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Financial numeracy is a type of numeracy in which mathematics is applied in financial contexts, involving specific domain demands (Gal et al., 2020). In a broader sense, and in line with numeracy as a social practice, financial numeracy is not limited to developing mathematical knowledge in financial contexts. It also involves understanding financial concepts through mathematical investigation and examining their connections to the economic system and other systems (e.g., politics, ethics), thereby encouraging a critical orientation regarding the social and ethical implications of financial decisions (Blue et al., 2018; Savard & Cavalcante, 2021). While often used interchangeably with financial literacy, the term financial numeracy foregrounds the role of mathematics in financial competence.

Money as a Special System of Measurement

Savard et al. (2020) argue that, in primary school, money should be addressed explicitly as its own system of measurement with the aim of deepening students' understanding of what money represents and how the economic value of products and services is defined and can be questioned. This perspective is particularly relevant to a broader view of financial numeracy, which involves examining financial concepts such as prices through mathematical investigation and critically examining existing financial practices, such as pricing decisions. Regarding prices and pricing, students need to understand that determining the economic value of a good or service differs fundamentally from measuring physical quantities such as length or weight. For instance, deciding how much to charge, or pay, for a loaf of bread requires considering multiple variables. For example, the quantity and type of bread, and the place of sale, all influence its economic value. Moreover, how these variables are weighted is not fixed but is negotiated and agreed upon by the parties involved in the economic transaction (Savard et al., 2020). Winter (1992) formulated similar ideas in mathematics education by distinguishing between different types of modelling. The measurement of physical quantities, such as length, relies on descriptive models. In contrast, everyday activities between people - particularly financial transactions - are based on normative models. Both Savard et al. (2020) and Winter (1992) therefore argue that mathematics lessons should help students understand that setting prices is fundamentally different from measuring physical quantities such as length or weight.

Investigating Children's Funds of Knowledge about Financial Concepts

In Australasian mathematics education research, a Funds of Knowledge approach has been used to examine how children's experiences with money at home and in their communities shape their engagement with financial learning and how they mathematise financial situations. This perspective assumes that classroom learning can be enhanced when teachers understand students' household and community experiences (Moll & González, 2012). For example, Hunter and Sawatzki (2019) found that 10–12-year-old students drew on social and cultural norms when using mathematics to justify financial decisions in a task about paying for a family meal bill, discussing what "value for money" meant to them. Furthermore, Sawatzki and Goos (2018) showed that students' pricing decisions depended on the funds of knowledge they drew upon: some prioritised social considerations and avoided setting prices too high, often resulting in loss-making responses, while others who gave profit-making responses relied on financial or entrepreneurial knowledge, referring to financial concepts such as "cost", "price", and "profit" in their proposed solutions. Similarly, Blue et al. (2018) found that Year 4 students needed to connect ethical, social, and mathematical considerations when solving pricing problems.

While several studies in the Australasian context have examined how primary school children perceive financial problem contexts and the financial concepts they contain, there are currently few similar studies in Germany. As a result, relatively little is known about whether German primary school students recognise the special system of measurement behind pricing and what funds of knowledge they draw upon when explaining prices. Addressing this gap, the present study investigates the following research question:

- How do third- and fourth-grade students conceive of prices, and what challenges and potentials do these conceptions pose for the promotion of financial numeracy?

Methodology

Research design and participants

The research question was embedded in a larger Design-Based Research (DBR) study examining how financial numeracy can be promoted in third- and fourth-grade mathematics lessons. The overall project comprised two DBR cycles: cycle 1 (2023) involved 16 students (9 third graders, 7 fourth graders), and cycle 2 (2024) involved a different group of 15 students (10 third graders, 5 fourth graders). A qualitative approach to data collection and analysis was adopted to gain deeper insights into students' thinking and reasoning. Across both cycles, data were collected through semi-structured pre- and post-intervention interviews and participatory classroom observations during the intervention, which took the form of a simulated classroom economy. In this setting, students made financial decisions, enabling the exploration of their financial knowledge, attitudes, and behaviours. Participation in the DBR study was voluntary and took place within an after-school program. The participating children came from two rural schools in Southern Germany. Most children were from middle-class backgrounds with diverse cultural backgrounds. They demonstrated differing levels of mathematical achievement, as indicated by their mathematics grades. Unlike Australia, where financial literacy is a curriculum connection, it is not yet explicitly embedded in the German curriculum, which likely affects how money and finance are addressed in classrooms. In both countries, money is included in the measurement strand of the mathematics curriculum. In cycle 1, the design-research focused on individual purchasing practices, reflecting a narrower view of financial numeracy centred on personal money management. The research focus of cycle 2 shifted to students' understanding of prices and the social and economic implications of pricing practices, to inform the redesign of the intervention towards fostering financial numeracy in its broader **sense**. This paper draws on pre-intervention interviews from cycle 2 to analyse students' initial conceptions of prices. The following sections outline the data collection and analysis procedures in detail.

Data collection

To inform data collection, prior research on children's price conceptions was reviewed and interview questions were adapted from established studies (e.g., Berti & Bombi, 1988; Claar, 1990; Leiser & Halachmi, 2006). Table 1 presents an excerpt of the posed questions.

Table 1

Sample Questions for Exploring Children's Price Conceptions

Key Questions for the Interview
Do you know how much an apple and a bar of chocolate cost at the moment?
An apple currently costs between 30 and 50 cents. How is the price of an apple determined?
Why is the price of a bar of chocolate usually higher than the price of an apple?
Imagine that an apple used to cost 30 cents. Now the price has risen to 40 cents. Can you explain why this might happen? If necessary, ask: Are there any other reasons?

Note. Similar questions were asked about other everyday products. Product pairs for price comparison were selected that were likely to be familiar to the students and that allowed exploration of whether students considered factors beyond physical characteristics (e.g., size or weight) when explaining prices. For example, students compared a sack of potatoes (2.5 kg) with a box of chocolates (100 g) and were asked which product was more expensive and why. Although the sack of potatoes is heavier, it can still be cheaper than the box of chocolates, as other price-determining factors need to be considered.

The 15 children in DBR cycle 2 were interviewed in pairs. This dialogue-based format aimed to create an open, conversational atmosphere and allowed observation of how children interact when explaining and justifying their answers. The entire pre-intervention interview

lasted approximately 30–40 minutes, with the section on pricing taking about 5–10 minutes. All interviews were audio-recorded and later transcribed. Using a semi-structured interview guide allowed the interviewer to react flexibly to students' answers and ask additional questions, enabling a deeper exploration of their thinking and reasoning. Follow-up questions were included to investigate whether children could think of other possible explanations, with the aim of obtaining as comprehensive a picture of their understanding as possible. Depending on the students' responses, further probing questions were asked. For example, to explore whether students recognised that prices cannot be lowered indefinitely due to needing to cover costs, the follow-up question "Can the price of an apple also fall to 10 cents or less? Why or why not?" was posed if children had already mentioned supply and demand as reasons for price changes.

Data analysis

Interview data were analysed using qualitative content analysis (Mayring, 2010). Students' responses to the pricing questions were first coded using a deductive category system derived from Claar's (1990) framework of children's evolving price understanding (see Table 2). Although Claar's study is comparatively dated, it remains one of the few that provides a comprehensive conceptualisation of pricing within a market economy. The categories represent increasingly differentiated and integrated conceptions of price formation, with price-determining criteria becoming, in the latter categories, more general, abstract, and less directly tied to the physical characteristics of products.

Table 2

Categories for Analysis of Children's Price Conceptions, adapted from Claar (1990)

Category	Summary Description of Category
A: Price determined by product characteristics or functionality	Prices are based exclusively on specific characteristics of the product (e.g., size, weight) or on functional criteria relating to the use of the product (e.g., usefulness, durability).
B: Price determined by one cost factor	The amount of work involved in manufacturing and distributing a product is considered as a basis for the price. Only one cost factor (e.g., transportation costs) is mentioned.
B-2: Price determined by several cost factors	The amount of work involved in manufacturing and distributing a product is considered as a basis for the price. Several cost factors (e.g., costs for materials, transportation and advertising) are mentioned.
C: Price determined by supply and demand	In addition to costs, it is considered that supply and demand influence prices. The functional relationships between supply, demand and price can be explained (e.g., when demand exceeds supply, the price increases).
C-2: Price determined by integration of supply and demand with costs	Costs, supply and demand are combined in the reasoning and explanation of price formation. For example, it can be explained that prices cannot be reduced too much because then costs would no longer be covered.
D: Market imperfections included in price explanations	Deviations from a perfect market, such as incomplete market transparency, location advantages or the influence of advertising and brand image, are considered when explaining prices.

In a second step, the analysis focused on the everyday experiences and contextual knowledge students drew upon when explaining prices. These references were interpreted through a Funds of Knowledge lens as indicators of the knowledge sources that informed students' reasoning (e.g., shopping experiences or local debates about prices they witnessed).

Findings

In presenting the findings, pseudonyms are used for all students, and interview excerpts are translated verbatim into English**.** Most children's pre-intervention price conceptions were coded

as part of category A, where prices are derived solely from product characteristics such as size, weight, or functionality. While such attributes can influence price, relying on them alone to explain price formation does not fully reflect economic reality. For instance, a lettuce is not more expensive than a keyring simply because it is larger. The following excerpt illustrates this, showing how Helena explained the price difference between a bar of chocolate and an apple.

Interviewer: Why do you think the bar of chocolate costs more than the apple?

Helena: Because chocolate is longer/well, it is a little longer.

Helena treated length as the sole price-determining factor, concluding that the chocolate bar was more expensive simply because it was longer.

Weight or size was also frequently cited as the only reason for price differences between products. Some children reasoned that a bag of potatoes (2.5 kg) was more expensive than a box of chocolates (100 g) because the potatoes were heavier. Others argued that the sack of potatoes was more expensive because it was larger. In some cases, the price was also explained by the functionality of the products, for example, arguing that potatoes are more expensive because they can be used to make many different things (e.g., chips or crisps), whereas chocolates are less versatile.

A focus on physical attributes also appeared in explanations of price changes, which many children attributed only to differences in size or weight. Mira, for example, assumed that a price increase for a product was only possible if the properties of the product also changed – in her opinion, apples could only become more expensive if they also became larger.

Interviewer: And then, let's say the apple used to cost 35 cents. And now the apple suddenly costs 40 cents. How can you explain that? How can that happen?

Mira: Maybe it has become heavier.

A similar argument was also found in Helena's and Selina's responses to the interview questions, who said that the price of an apple can only increase if this is accompanied by a change in its weight.

Interviewer: And now the price has suddenly been increased to 40 cents. Why might that be?

Helena: If it's a heavier apple.

Interviewer: So, if it's heavier, it is more expensive? (Helena nods) Could there be other reasons, or can it only be due to the weight?

Selina: It can only be due to the weight.

Some children also mentioned the amount of work involved, expressed as individual cost factors, in the production and distribution of products, which was coded as category B. For example, Ines contradicted Lilia's statements, who justified the price of an apple by reference only to characteristics such as weight and width, and instead referred to production costs, specifically water usage in apple cultivation.

Interviewer: An apple costs between 30 and 50 cents. Do you know how that price is determined?

Lilia: I think it's based on weight and width.

Interviewer: So how big the apple is, you mean?

Lilia: Yes.

Ines: I think it's more to do with production. For example, we recently discussed the topic of water, and abroad an apple needs one litre or so. And in Germany, it only needs 200 or 500 millilitres. Maybe that's what it depends on.

Justus, on the other hand, addressed transportation costs that affect apple prices.

Justus: Well, there are no apples in Germany at this time of year, in winter. So, they have to be transported across the oceans by boat, and now, with the war in Ukraine, the boats may have to travel further. So somehow that has to pay off.

Supply and demand (category C) were rarely mentioned by the children in the pre-intervention interview as possible factors influencing prices. One exception was Nils and Robin who cited a supply shortage as a possible reason for a price increase.

> Interviewer: An apple used to cost 35 cents, but now the price is increasing to 40 cents. How can that be? What could make it more expensive?
>
> Nils: Yes, if there aren't as many apples anymore.
>
> Interviewer: So, because there is less supply?
>
> Nils: Yes.
>
> Robin: That there might be a big drought and then there's not as much rain.
>
> Interviewer: So, then there are fewer apples, and then you can make them more expensive, do you think?
>
> Robin: Yes.

In addition to changes on the supply side, Nils and Robin also mentioned individual cost factors – such as transportation costs – as price-determining factors. However, there was no evidence of an integrated argument linking supply, demand, and costs (category C-2). Furthermore, they were only able to explain a price increase by means of a shortage of supply but could not justify a price reduction with changes in supply or demand.

When children discussed supply and demand, they sometimes assumed different functional relationships among supply, demand, and price than those described in economic theory. For example, Loris initially assumed a "more-is-more" logic, according to which a larger supply of apples (with demand remaining constant) leads to higher prices.

The interview discussions provided insights that extend beyond a simple categorisation of students' answers. In particular, they show how students' explanations of prices evolved during the course of the interview and how, in some cases, an emerging critical orientation toward pricing decisions became evident.

In some cases, children noticed a contradiction in their stated price-determining factors over the course of the interview as soon as they tried to apply them to other products and realised that their reasoning no longer applied. For example, Loris and Mira initially argued that size and weight were the only price-determining factors but then came across counterexamples where this explanation no longer seemed to apply. Loris noted from his own consumer experience that there are products that are larger than others but are not more expensive, and that taste is not always the decisive factor in determining price.

> Loris: But I don't think it's because of taste, because there are pizzas with pineapple on them, which a lot of people don't like, but they're more expensive than an apple, for sure. And maybe people just don't like pizza.
>
> Interviewer: That's the question, yes.
>
> Loris: And it's not because of how big or small something is either. Because there was a packet of cocoa that was small and cost 3, or 4, or 5 €, I'm not sure.
>
> Interviewer: So, the large one was cheaper than the small one?
>
> Loris: Yes.

Interestingly, without the interviewer prompting them, some children already critically questioned issues of equality and how prices affect others, especially when these issues were part of their lived experiences. However, their suggested solutions indicated that they did not yet fully grasp the systemic implications of pricing decisions within an economic system. For example, Emil had recently noticed farmer demonstrations for fairer payment for their products. Living in a rural area where many people work in agriculture, he suggested that the shopkeepers pay farmers more for their apples:

> Because, there's also a dispute at the moment because farmers don't get enough money when they sell their produce. But, for example, if they have children, they sell their fruit and vegetables and

meat. And if they want 3 € for it and people only pay 10 cents, for example, that's why there's a dispute. And I would, if I were a shopkeeper, I would give them 3, maybe 4 € for it, maybe a tip.

When the interviewer asked whether this would in turn require customers to pay higher prices, Emil suggested that the additional paid amount could be treated as a "tip" from the shopkeeper, without seeming to acknowledge that a shopkeeper aims to make a profit and is unlikely to cover such costs personally. His proposal, while well-intentioned, was therefore not a sustainable solution.

Interviewer: But then people would have to buy it for 4 €, right?

Emil: No, I would just charge 3 €, and I meant that the 1-euro coin is a tip.

Discussion

The findings presented above suggest that the majority of the third- and fourth-grade students in this study tended to view prices more as objectively measurable quantities tied to physical product features (e.g., length or weight), and less as subjective and negotiable constructs shaped by broader economic and social factors. This aligns with earlier research on children's economic reasoning, which indicates that children aged 8 to 10 often attribute prices mainly to physical characteristics of products (e.g., Claar, 1990). Such conceptions may present challenges for fostering financial numeracy in a broader sense, particularly with regard to developing a critical orientation (e.g., Goos & O'Sullivan, 2022). When students perceive prices as fixed and objective rather than socially negotiated, it becomes more difficult for them to make informed financial decisions, or to critically examine issues of fairness and inequality related to pricing.

At the same time, the findings suggest that children draw on rich funds of knowledge when reasoning about prices. Their explanations should therefore not be interpreted simply as incorrect conceptions but as working theories that help them make sense of pricing in everyday contexts. For example, explaining prices in terms of weight is not entirely inaccurate, as weight can influence price determination in some cases. Children may have experienced, for instance, when buying fruit or vegetables, that heavier quantities generally cost more. However, such explanations remain incomplete, as weight is only one of several factors influencing prices. The interviews also showed that children reflected on, and refined, their explanations during discussion. Some recognised inconsistencies when applying their reasoning to different products, as illustrated by Loris, while others challenged each other's ideas and proposed alternative explanations, as in the exchange between Lila and Ines. These interactions suggest that classroom discussions can support the development and refinement of students' reasoning about prices.

Furthermore, some children demonstrated an emerging critical orientation toward pricing decisions. For example, Emil explained apple prices by referring to farmers receiving insufficient payment for their products and suggested that shopkeepers should pay them more. His reasoning was primarily grounded in social rather than economic reasoning. Similar patterns have been reported in previous studies, where students' reasoning about financial situations was often shaped by social and ethical concerns (e.g., Blue et al., 2018; Hunter & Sawatzki, 2019; Sawatzki & Goos, 2018). While such responses indicate a sensitivity to issues of fairness and inequality, they also highlight the need to support students in developing a more integrated understanding of pricing practices and in considering how practices might be changed to promote greater fairness by connecting social, economic, and mathematical perspectives.

Conclusion

This study contributes to knowledge by providing insights into how some German primary school children conceive of prices and by discussing both the challenges and potentials these

conceptions may pose for developing financial numeracy. The findings suggest that many third- and fourth graders initially view prices as objectively measurable quantities linked mainly to physical product characteristics but are also able to modify their conceptions through drawing on their funds of knowledge and in discussion with others. Furthermore, some are also able to question existing pricing practices. The findings suggest that students should be supported to extend their knowledge by empowering them to critically explore how prices are formed and how they shape social and economic reality, rather than viewing prices as purely objective, descriptive measures. These findings informed the subsequent design phase of the broader DBR study, in which financial numeracy tasks were developed to support students in connecting social, economic, and mathematical perspectives when analysing price formation and evaluating pricing practices. This study is limited by its small sample size and limited student diversity, which restricts the generalisability of the findings to how primary school students conceptualise prices. In addition, the analysis is based on responses to a limited set of interview questions and therefore provides only a partial view of the knowledge and experiences students may draw upon when explaining prices. Alternative questions or additional data collection methods might have provided further insights into students' reasoning about prices.

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