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Teaching proportional reasoning and the reduction of inequality through taxation

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Research Article

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Abstract

This is a case study to investigate how students and other people understand and change their beliefs regarding economic inequality, and how they use proportional reasoning to do so. We do this by analysing their discussions when they are asked what kind of taxation they think is fairest: all pay the same fixed amount; all pay the same fixed proportion; or people pay a variable proportion (progressive taxation). We notice that the participants are confronted by conflicting beliefs, and we have analysed how they grapple with these socio-cognitive conflicts, and what kinds of reasoning they use. Our analysis is helpful in figuring out how teachers should address problems of poverty, economic inequality, and taxation. We conclude that students need to have opportunities, as exemplified by our study, to have discussions with each other in which they engage in authentic argumentation that will allow them to critique important questions related to the UN Sustainable Development Goals and perhaps change their beliefs regarding the reduction of inequality.

1. Introduction: Exploring inequality and proportional reasoning in schools

Education for social justice and reduced inequality is a crucial component of efforts to implement the UN Sustainable Development Goals (UNSDG), particularly, Goal 1: End poverty in all forms everywhere, and Goal 10: Reduce inequality within and among countries (United Nations, 2015). However, even as education in India increases, the gap between the rich and the poor spirals to unimaginable heights. While our society reveres the wealthy, hordes of poorer people are left to internalise their oppression, have low self-worth, and blame themselves for their poverty. Wealth, even extreme wealth, is not seen as being problematic, or as causing poverty. Perhaps inequality is naturalised as an inevitable part of present day life. This is despite the possibility that there are some obvious remedies: e.g. taxing the super-rich might reduce inequality and poverty.

As science educators who take the UNSDG seriously, we want to take bold steps to address these problems. We think that teachers should not shy away from trying to change students' beliefs on such important problems such as these. We should try to inspire our students to go beyond mere understanding and to take action to advocate for the reduction of economic inequality.

Understanding economic inequality and taxation requires proportional reasoning, which is commonly part of the school mathematics syllabus. For example, there are two chapters on "Proportional Reasoning" in the NCERT Class VIII Mathematics textbook (NCERT, 2025) that is used in India (and is used as a basis for designing other textbooks in India). Since most of the classroom teaching throughout the country is textbook based, this gives us a rough idea of what is being taught throughout the country.

The text introduces the idea of numerical ratios to describe proportions and gives step-by-step directions on how to solve problems using the given formula. Although a few of the questions in the text could be

related to sopoec (social, political, economic) problems, there are only one or two examples where a social question is mentioned (e.g. after calculating differences in prices of tea, the students are asked why tea may be costlier from a small farm than a large farm in another part of the country). Generally, social problems are not discussed in mathematics textbooks or classes.

Presumably, the 'good' students will follow the correct procedures and get the correct answers to the numerical problems involving proportional reasoning, although it is not clear whether they will be understanding much about what they are doing and why they are doing it.

We want to know what students are understanding and how they solve such problems using logic rather than following the prescribed procedures. We have previously used a proportional reasoning problem from a workshop session conducted by Eleanor Duckworth (Duckworth, 2006). The problem she proposed was to figure out which imaginary cups of coffee were milkier: (1) a cup having 2 units of coffee and 1 unit of milk; (2) a cup having 4 units of coffee and 2 units of milk; (3) a cup having 3 units of coffee and 2 units of milk; or (4) a cup having 4 units of coffee and 3 units of milk (Figure 1). We used two different colours of buttons to represent the units of milk and coffee, and we were told to figure out the answer the way young children figure it out - without using fractions or formulae.

This problem is surprisingly difficult. People use what seem like equally logical arguments to come up with contradictory answers. For example, according to one argument, (1) and (2) are equally milky because (2) is the same as two cups of (1). Also, (3) is the same as (1) because if we remove one part of milk and one part of coffee from (3), then it is the same as (1). But on the other hand, (2) is definitely less milky than (3) because it has one more part of coffee with the same amount of milk. So then, how can it be that (1) is the same as (2), and (3) is the same as (1), but (2) is not the same as (3)?

Although the milk and coffee problem is very absorbing, it may not be terribly relevant to students' own lives. Believing in the interdependence between mathematics and social sciences, and in the need for interdisciplinary teaching, we decided to focus on a problem in which proportional reasoning is used to explore the real-world social problem of inequality and income tax.

This problem is particularly relevant in these times of increasing wealth inequality, when some people are considering modifying tax structures in order to reduce economic inequality (Piketty et al., 2023). It is a problem that is relevant to citizenship, democracy, national patriotism, political beliefs, and the aims of different systems of governance. It is also a problem for which people have different points of view and do not agree on one correct answer.

2. Background

It has been found that students and adults in the USA do not realise that economic inequality in their country is as severe as it is (Arsenio & Willems, 2017). It is not known whether this is also true in other countries such as India, but according to our experience, it is likely. Failing to address the existence and injustice of economic inequality could be the result of bias and/or indoctrination (Bogard et al., 2026).

But the recognition of inequality does not guarantee a belief in the need to reduce inequality or the recognition that this could be done through progressive taxation methods (Salvador Casara et al., 2023). People may not use correct proportional reasoning to realise that inequality results in unfair taxation if everyone pays the same fixed amount of tax. It is equivalent to thinking that removing one spoon of milk from a large cup and a small cup of milky coffee has the same effect.

Various researchers have advocated that students need to develop moral reasoning in relation to taxation methods. For example, Elaine Doyle (2015) says, “If ethical standards in tax are to be encouraged, tax education must embrace effective methods of enhancing the moral reasoning of students [especially business school students]”.

Many reports have been published which raise questions as to whether learning goals in science (and social science) education should be focussed on acquiring knowledge, understanding, and/or changing beliefs, attitudes, moral values, or behaviours (Southerland et al., 2001). While researchers - and teachers - find these questions to be important, they do not agree on which sorts of goals are appropriate. One researcher wrote:

“Many if not most authors including myself question the propriety of changing beliefs as a goal of public instruction in a democratic society. If a goal of our instruction is to change student beliefs, are we not liable to charges of indoctrination?” (Smith, 2010)

The author saw ‘believing’ as different from ‘knowing’ or ‘understanding’, in that beliefs are less justified and less interconnected. However, in this paper we will use the word ‘belief’ to mean any type of belief: either an unjustified belief or a justified true belief (knowledge). Regardless of such distinctions, it is hard to imagine that we can avoid learning goals that include changing understandings or beliefs.

When educationists talk of changing students’ beliefs, they usually talk about changing erroneous beliefs or misconceptions in fields such mathematics or physics (Trevors, 2023), where it is not too difficult to distinguish between what is true and what is false. Here we are talking about changing students’ beliefs so that they believe a progressive method of taxation is fairest and is needed to reduce inequality. Whether inequality should be reduced depends on one’s point of view. We believe it is incorrect to think that extreme inequality is acceptable, but others (especially very rich people) may disagree. They may not agree that the UN Sustainable Development Goals are correct.

Some educationists think that teachers should take an impartial stance regarding controversial sopoec issues in their classrooms, presenting different points of view in a fair, balanced way (Maxwell, 2025). This requires being able to define which issues are controversial, which is done according to behavioural, epistemic, or politically authentic criteria. Bruce Maxwell discusses these criteria and their limitations, and advocates an alternative framework based on students’ rights and teachers’ responsibilities. He concludes that teachers need not try to be impartial if their role as a disciplinary expert requires partiality, or if partiality is required to ensure that a classroom is a respectful and inclusive place.

Accordingly, we may agree that teachers have a duty to act as human rights advocates, which includes advocating for the reduction of economic inequality.

Some educationists do adopt a 'principled approach', arising from concerns for social justice and equity. An example is the Masters elementary teacher education program at Mills College in USA, for which certain principles are explicitly stated, including: "Teaching is inherently moral work that must be guided by an ethic of care," and "Teaching is inherently political in that by definition, it is concerned with matters of change that are neither neutral nor inconsequential" (Kroll, 2004). These principles are stated in order to "prompt students to consider their own values and beliefs in relation to their teaching".

Another question is whether impartiality, neutrality, or objectivity is even possible in teaching.. Even if a teacher takes a liberal/pluralist stance, a classroom is not separate from society: societal inequalities exist and thus it is not possible for multiple perspectives to compete on a level playing field (Kelly & Brandes, 2001). Political polarisation in classrooms "shapes who is heard, what knowledge is considered legitimate, and which emotions are deemed appropriate in educational spaces" (Zembylas, 2025). How can education be democratic in a society that has extreme inequality?

We do all have our points of view and ideologies, whether we recognise them or not (Zinn, 2011). Perhaps we can all agree that changing wrong beliefs about milk and coffee proportional reasoning is a worthwhile objective. But with regard to changing ethical, social, and political beliefs, there is disagreement. However, we are fooling ourselves if we deny that changing such beliefs are objectives of education (linked to the UNSDG).

We were interested in exploring what happens when students are presented with different methods of paying tax and asked to decide for themselves which one is best. This might be compatible with the belief that teachers should take an impartial stance regarding a controversial issue. But, it would be disingenuous to claim that we did not have an opinion on this. We thought that economic inequality is unjust and a variable proportion method of collecting income tax is fairest, and would tend to decrease inequality. We actually hope that students come to agree with us, and if we were to teach, our opinion may influence the students.

This forces us to face accusations that would be trying to indoctrinate, rather than educate. Various educationists have addressed the definitions and differences between indoctrination and education. Indoctrination is usually thought to involve imposing unquestioned beliefs in a certain content, doctrine, or ideology (De La Herrán-Gascón & Rodríguez-Herrero, 2024). This might be intentionally done through manipulation or coercion, perhaps without students being aware that they are being indoctrinated. It is the opposite of education. Scientific argumentation - which includes debate between different views, rather than the acceptance of authority - plays an important role in maintaining democratic participation in society (Erduran & Jiménez Aleixandre, 2008).

We are interested in investigating argumentation: the process of ascertaining the epistemic value of statements. This includes a person arguing with themselves in order to justify and remove their own

doubts about the truth of a statement, as well as argument as a social exchange - people questioning, listening, interacting, and trying to persuade each other. We see the process of argumentation as embedded in a social and historical context. Contrary to researchers who consider reasoning to be individualistic, Sperber and Mercier (2012) argue that the function of reasoning is primarily social, and that groups do better at reasoning than individuals. In this study, we are interested in exploring the social dimensions of reasoning, in particular relation to socio-cognitive conflicts..

Socio-cognitive conflicts are both social and cognitive, and may lead to collaborative and creative learning, rather than imitating or social influencing (Perret-Clermont, 2022). They involve authentic argumentation in which the participants initially do not agree on a common answer, and work together to construct and justify an answer. This might facilitate pedagogies that escape the typical transmissive methods involving asymmetrical power structures and 'learning' static knowledge (Perret-Clermont et al., 2019)

A number of researchers have claimed that socio-cognitive conflict and dissent may stimulate cognitive activity and learning when students work in small groups. For example, some claim that

"socio-cognitive conflict is beneficial for learning to the extent that conflict is regulated in an epistemic manner; that is, by focusing on the task or on the knowledge at hand. On the contrary, socio-cognitive conflict can result in detrimental effects whenever conflict is regulated in a relational manner, that is, by focusing on status and on interpersonal dominance." (Butera et al., 2010)

How can we avoid detrimental effects? Perhaps it will help if we try to create situations in which friends can carry on discussions with each other without competition to get 'correct answers' or good grades. We want people to carry on authentic arguments about an authentic question - a question to which they are not sure of the answer and genuinely want to find it.

Some researchers have claimed that people usually prefer not to confront different points of view and unfamiliar arguments (Frey, 1986). Maybe this is one reason why dissenting viewpoints are avoided in classrooms. However, in our previous work with high school and undergraduate students, we have found that they became completely engrossed in carrying on friendly discussions in which they express and hear many opposing opinions regarding which is the fairest method of collecting income tax. This leads us to undertake the present study in order to understand more about such discussions.

3. Research Questions

We analysed discussions in which participants were trying to decide which method of taxation was fairest. Should all people pay the same amount, should people pay amounts that are proportional to their income, or should they pay a progressively higher proportion of tax depending on their income?

The problem is illustrated in the handout shown in Fig. 2. In line with an ideological stand against economic exploitation, the text was designed in such a way that it would lead students to understand

why the variable proportion (progressive) method of collecting income tax is fairest. It was originally published in a textbook for Class VIII students (13–14 year-olds) (Eklavya, 2004), although we have also used it for students in high school and at the undergraduate level.

In the present study, we wanted to find out:

1. 1. Did the participants have a good understanding of proportional reasoning?
2. 2. Which method of taxation did each participant think was best, what kinds of argumentation did they engage in, and how did their beliefs change during their discussion? How did this signify their points of view related to ethics, equality, and justice?
3. 3. What role should teachers play in changing students' beliefs? Should teachers try to teach that the variable proportion method of collecting income tax is fairest? Regarding the topic of proportional reasoning, inequality, and taxation, what is worth teaching - and to whom?

4. Methods

Over the years we have conducted numerous sessions in classrooms and workshops in which we ask students to work individually, or in pairs or small groups to discuss and decide which of three methods is the fairest way to collect income tax, and why, using the handout shown in Fig. 2.. The three methods were: (1) everyone pays the same flat rate; (2) everyone pays the same percentage of their income; and (3) a progressive method in which people with higher income pay a higher percentage.

We have recorded and analysed a number of these sessions, but here we will report on only three separate sessions. Each of these sessions was a discussion between two or three researchers and two participants, who we asked to work together to do the exercise written on the handout, discussing and thinking out loud as they do so. In every case, the two participants were fairly well known to each other, so they were friendly and talkative. They were chosen by convenience, since they happened to be available in the canteen of our research centre. The students BSc second year students of physics who were from upper caste and upper middle class backgrounds, attending a highly selective physics camp for meritorious students in Mumbai.

Session 1 was with researchers Karen, Rafikh, and Saurav, and two male canteen workers, Anil and Deepak, poor migrant labourers from the same extended family of poor farmers, who had come from Odisha to work in Mumbai. Since we did not know their mother tongue (Odiya), we conversed with them in Hindi. We read the text to them in Hindi, since we assumed they may not be fluent in reading Hindi.

Session 2 was with the researchers Karen, Rafikh, and Saurav, and two female students, Leena and Uma. Their mother tongue was Malayalam, but they were fluent in English and the session was conducted in English. We gave them a copy of the complete worksheet, and asked them to fill in the blanks and then discuss with each other which of the three methods of paying tax is fairest. The parts in italics were included in order to encourage them to be sympathetic to poor people.

Session 3 was conducted by the researchers, Karen and Saurav, with two male students, Kishor and Bijoy. Their mother tongue was Bengali, but they were fluent in English and the session was conducted in English. In this session, we gave the students an abbreviated form of the handout in which the parts in italics were omitted.

In all cases we watched the participants fill in the blanks to tell how much tax the three hypothetical people would pay for each method of tax collection, and checked their calculations immediately in order to be sure that they understood the three methods of tax collection before proceeding.

Each session was audio recorded, fully transcribed, and micro-analysed. We tried to understand what was happening throughout each minute of the session while keeping in mind the social and political environment and background in which the participants and the researchers act and interact. Our methods are influenced by those suggested by Roth (2005) in order to address his complaint that "Too often, however, researchers seem to be tempted to provide micro-level descriptions without considering more overarching temporal and physical constraints on the activities." We hope this analysis will indicate the participants' beliefs and changes in beliefs, so that we can understand something about how learning may be occurring in the conversations we are studying. Our effort is to understand these particular conversations rather than to make generalisations. The complete transcripts of the conversations are freely available online [link to be provided upon publication].

5. Results and Discussion

5.1 Two Male Canteen Workers, Anil and Deepak

Our session with Anil and Deepak was only ten minutes long because they could not take off much time from their work as cooks in our canteen. We were not sure if they would be able to calculate percentages, since we knew they had not had the opportunity to complete their schooling because they had migrated to Mumbai for work at fairly young ages. However, Anil and Deepak took turns filling in the blanks, and they were able to do so without making any mistakes, although it took them a little time to calculate 30% of ₹20,000. We concluded that they had a good, working understanding of proportional reasoning.

We then asked them which method they thought was the fairest method of collecting tax. From the start of the conversation, both workers agreed that Method 2 is the fairest. The reason, as Anil explained, was "because look, it's like this - if there is a poor person - like we are poor people - if we only have ₹1000 then how can we pay the tax - what will we have left? There will be a problem." To further explain why Method 1 is not fair, Anil said, "For him [the rich person], ₹50 is nothing." This indicates a good application of the concepts of proportions and equality and the social context.

When we asked why they do not think Method 3 is better, they replied, "No, but it's like this: if these guys [those who pay a lot of tax in Method 3] see the poor person who pays no tax, they will fight with them [□□□ □□□□□ - literally, beat or kill them)]!" In other words, they did not believe that Method 3 is practical. But

maybe it is more than that. Deepak argued that it is not correct that the poorest people do not pay any tax at all. He said, “At least the poor person can give something - even just 2 rupees.” Perhaps his sense of fairness includes a belief that everyone has a responsibility to do something, even if they cannot afford to do much.

Thus, we saw that Anil and Deepak both seemed to believe and understand why Method 1 is not fair.

5.2 Two Female BSc Students, Leena and Uma

Our session with Leena and Uma lasted 32 minutes. They took a few minutes to silently read the entire handout, and then work together to fill in the blanks, which they did without error, indicating that they had a good understanding of proportional reasoning.

When asked which method is fairest, Leena said: “I think I’ll go with variable proportion. That seems to be more fair.” Uma agreed and explained - using the same argument given in the text, “Because if she [Jyoti] can’t even afford to ah - feed her children - that is a basic necessity - then she cannot pay the tax.”

Then we said, “Why not [Method 1]? It’s fair, because everyone pays the same.”

Uma replied, “Yeah everyone pays the same but ... if this person gives 50 rupees it doesn’t affect him. ... but if she [Jyoti] gives 50 rupees -“ Leena said “equality doesn’t mean justice”, and Uma explained, ”because in these cases, these three, they are not equal in economic ways so making them pay the same amount ... It’s not the same percent of their earning.”

Based on this much of the discussion, we might think that Leena and Uma understand proportions and understood why Method 3 is more fair than the other methods of collecting income tax. However, we went on to ask them another question which was not on the handout: “Is income tax more fair than sales tax?” We were surprised when, after a long pause, they both agreed that sales tax is more fair. Even after 10 more minutes of discussion on this question, in which the researchers continued to ask questions and question the students’ answers, they both stuck to this belief. They even said that all economic classes of people would agree that sales tax is more fair than income tax.

They did not realise that indirect taxes, such as sales tax, are regressive. By the same logic that Method 1 is an unfair way of paying income tax, sales tax is also unfair. Their thinking that sales tax is more fair leads us to question whether they really understood why Method 3 is more fair, or whether they were just saying it was more fair because that is what the extended text implied the correct answer was. Was the text in italics manipulating or indoctrinating the students, rather than encouraging them to ask questions?

5.3 Two Male BSc Students, Kishor and Bijoy

This session is the main focus of our study. Wanting to find out how students would argue if the handout was less subjective, We gave Kishor and Bijoy the handout without the parts in italics. The researchers also tried to take a less active part in the discussion, and refrain from letting them know what we

thought. We occasionally restated a statement or a previous argument they had made, or asked questions to clarify their statements. Our main role was to let the students know that we were interested and following their discussion. For the next 30 minutes the two students kept up the discussion with each other with little input on our part. They were very involved and showed no desire to wrap things up, continuing their discussion as they left the room. We have found this level of interest every time we have tried this exercise with students, whether with students of Class VIII, High school, or BSc.

Kishor and Bijoy had no trouble calculating how much tax each person would pay with each of the three methods and filling in the blanks in the handout. Throughout their session they argued with each other, and both kept changing their stances and offering different reasons for why one or another method was more or less fair. Table 1 summarises the session, showing whether they probably meant each argument to be in favour of Method 1 or 3, or whether the argument did not seem to be for a particular method. (They never chose Method 2.) This is our subjective classification, and we realise that it may be erroneous at places, but we found it useful to give a general picture of the discussion. We used it to plot the changes in their beliefs (Fig. 3). The incidences when either one of the students made a direct statement that ‘Method X is fairest’ are indicated by the circles and triangles in this figure.

Table 1

What is the fairest method of collecting income tax? Two students, Kishor (▯blue) and Bijoy (▲pink), tried to answer this question during a 40 minute discussion, in which they compared the three methods given in Fig. 3. This Table lists the reasons they gave as to why either Method 1 or Method 3 were fairer (i.e. the ways they attempted to define 'fair' at each point in the discussion (Purple indicates that Kishor and Bijoy expressed agreement on the same point.) Arguments for Method 1 are on the left and arguments for Method 3 are on the right. In case an argument is not clearly supporting either Method 1 or Method 2, it is shown as traversing both columns. Arguments regarding whether the government is able to collect enough money are indicated in red. Arguments regarding complaints are indicated in yellow.

Time	Reasons why Method 1 is more fair	Reasons why Method 3 is more fair
2:25	▯ Not fair for some to pay nothing in Method 3	
2:35	▯▲ Sudden jumps in tax (brackets) are not fair, and will lead to corruption, but Method 2 is also unfair because it is linear	
3:25		▯▲ Fairest if modified to have smaller intervals
9:50		▯ Not fair to pay a greater percentage if you earn less
10:05		▯ If tax is more than income, people will be in debt
10:40		▲ Should try to equalise
11:06		▲ Difficult to collect more than someone earns
11:40		▲ If you keep tax very low (as required for Method 1) the govt will not get enough
12:15	▲ Fair depends on how much money the government needs	
13:00	▯ No harm, if the government gets enough this way	
13:20	▯ Not fair for rich to lose what they earn	
13:40	▲ Depends on philosophy: if govt not requiring	
13:50		▲ Depends on philosophy: if govt requiring more money, & wanting parity
14:12		▲ Govt needs money and cannot take all away from a farmer
14:30	▯ If the govt does not need much money	
15:15	▲ Fair by analogy to buying IITadmission forms - everyone should pay the same	

Time	Reasons why Method 1 is more fair	Reasons why Method 3 is more fair
15:20	□ Not by analogy to buying forms - but because it is more or less stable and poor people (farmers) do not buy IIT forms	
15:35		□ Method 1 not fair, because the poor will have a grudge
15:45	□▲ Not fair, unless the poorest have enough left for their daily requirements	
16:55	□▲ Fair if the amount of tax is small compared to earnings	
17:25	□▲ Fair if the poor do not protest (if the amount is small compared to earnings)	
17:50		□ Method 1 may not give govt enough money because the amount may have to be set low enough so that people can still sustain
18:10		▲ There is no limit to what govt needs
19:15	▲ Use for vote banking	
19:45	□ Even without complaints, (1) may not be the fairest way	
19:50	▲ You have to make a compromise between fair and what is needed	
19:55	□ Fair will vary from person to person	
20:05	▲ According to ideology of equality	
20:05		▲ According to ideology of need (of govt)
20:10	□ Ideology of equality in collecting same amount of taxes regardless of earning	
20:20	▲ Each citizen is same (regardless of earning)	
20:30	□▲ Differences in earning are due to circumstances, not anyone's responsibility (so should not be the basis for judging fairness?)	
20:45	□ Differences in earning are not due to differences in capability (so should not be the basis for judging fairness?)	
20:50	□▲ Differences in earning are due to genetic differences causing unequal efficiency	
21:15	□▲ There is unavoidable division of labour and inequality	
21:20	□ Fairest because uniformity in earning is not possible	

Time	Reasons why Method 1 is more fair	Reasons why Method 3 is more fair
21:25		▯ Fair means practical - the govt needs money to run everything
22:00	▲ Fair is equal: everyone pays the same exact figure	
22:05		▲ If by equality we mean the same percentage of the salary
23:35		▯ Fair if the maximum number of people have to pay very less and therefore have no complaints
26:30		▲ Fair because fewer people pay tax (are deprived of their earnings)
27:00	▯ Method 3 is unfair because a few people pay tax for the whole country	
27:08		▲ Method 1 is unfair because many people are deprived of their money (and a greater fraction of their money)
28:20		▲ It is more efficient, which is better
28:40	▯ Fair is not the same as better	
29:00		▲ Fair because fewer people are deprived of their money
29:15	▯ Fair to whom? The govt? the people? the rich? the poor?	
29:30	▯ In Method 3 the rich will complain that we are paying all the taxes	
29:35		▲ Fair because the rich can't complain because they are not paying a large fraction of their earnings
29:45	▯ Method 3 is unfair because there is no reason why a few should feed the majority	
30:10	A large number of people are having a grudge	
30:15	▯ They are not having a grudge	
31:20		▲ Fairness should be determined on the basis of the fraction, because lower class people will otherwise complain that they are giving a larger fraction of their earnings as tax
31:15	▯▲ Fairest if fairness should be determined on the basis of the absolute number	▯▲ Better if fairness should be determined on the basis of the fraction

Time	Reasons why Method 1 is more fair	Reasons why Method 3 is more fair
31:30		▲ Fair because the higher earner can afford but the lower earner cannot afford to lose so much money for tax
31:45		Fair by analogy to a rich person paying a larger tip at a hotel
32:10		▲ Fair because rich people have so much money they cannot use it all, so they don't care if it goes to tax
32:30		▲ Intuition says to go for a fractional thing - throughout life you see fractional things, you don't see absolute figures
33:30		▲ In order to introduce non-linearity, to prevent a salary from going to infinity
34:20		▲ Fair for the govt because the govt wants money to be circulated
34:40		▲ Fair because money should be dispersed, not concentrated in 1–2 places
35:00		▲ So that lower classes will not complain
35:20		▲ Fair because it does not allow clumping of capital
35:30		Not fair for a very rich person to pay low percentage
36:05	Fair because you are taking a fixed amount from everyone so no one can complain	
36:30		▲ In Method 1 large numbers of people (lower classes) will complain
36:40	Fair by analogy to standing in a queue to buy something - everyone should pay the same price	
37:00	It's less bother	
37:10	It is possible to fix the amount low enough so that all can afford to pay it	
38:10	Even if the govt gets the same total amount of tax - why make a distinction between different people	
38:20	Unfair because it's like punishing a certain class of people even though they have done no crime	

Time	Reasons why Method 1 is more fair	Reasons why Method 3 is more fair
38:45		▲ No one has done a crime, but still some class has to suffer in both methods - so take the method which leads to fewer people complaining
38:55	▯ In any taxation method some class must suffer - so take the most efficient method	
39:20	▯ Fairest if the govt does not need more money (or if both methods give the same total amount of tax), and if everyone can still live happily after giving ₹50	▲ Fairest if both methods give the same total amount of tax

Four main themes emerged which dominated the 40 minute session with Kishor and Bijoy: (1) the mathematics of the problem; (2) the needs of the government; (3) peoples' complaints; and (4) equality, fairness, and genetic determinism. There was a constant intermingling of these themes throughout the session.

5.3.1 The mathematics of the problem

When first asked which method is fairest, Kishor began by saying, "Definitely not this one [Method 3], because earning less than 4000 there's zero percent tax - that's not fair. You can have many means of earning - you can then fool -" By 3:25 Kishor changed his stance, not by considering the hardships of poor people, but by considering the mathematical details and the logical consistency.

They proceeded to discuss how Method 3 is unfair if it has sudden jumps in tax with small increases in income, because this might tempt taxpayers to lie in order to fit into lower brackets. Bijoy then proposed a slight modification so that the intervals would be less abrupt, and at 3:25 they both agreed that their slightly modified Method 3 would be "the best one".

They then discussed what the graphs of salary vs. tax would look like for each of the three methods, and whether they are linear or exponential. Without actually making any graphs (although they did have a paper and pencil), they said that the graph of salary vs. tax would be linear and parallel to the x-axis for Method 1, linear and increasing for Method 2, and "like an exponential, but having some intervals" for Method 3. For the next 5 minutes they continued discussing the details of how the tax is calculated in Method 3 and how income tax in India is actually calculated. It is like a modified Method 3 in which people pay 10% only on their earnings between ₹4000 and 5000, and no tax on their earnings below ₹4000 (and similarly for the other tax brackets). By 9:40 they decided that actually the intervals may not be too abrupt and both Kishor and Bijoy agreed that Method 3 is the fairest method. Thus, for the first 10 minutes, they had made calculations and mental representations, and their conversation had included only technical and mathematical aspects. Clearly, their background in physics was affecting the reasoning they engaged in.

Playing the devil's advocate, at 9:45 Karen said that in Method 1 "everyone is paying the same tax, so it's very fair". Kishor replied, "But the one who is earning less has to pay a large amount of the percentage to the tax," indicating that he understood proportions and their relevance to the question of fairness.

At 10:10 Bijoy said, "In a population you have a distribution of earnings, so if you subtract the same amount from each of them, the distribution looks same [for Method 1]." Kishor agreed, saying, "If you subtract a constant amount - you're just shifting the axis". They were both mentally visualising the problem graphically.

5.3.2 The needs of the government vs the needs of the people

Throughout the discussion, Kishor and Bijoy kept referring to the needs of the government in order to decide which method of collecting tax was fairest. They were concerned that Method 1 would not give the government the most money.

At 10:05, Kishor said, "What happens if someone earns less than 50? He will be in debt." But apparently they did not immediately think this would make Method 1 impossible. It was not until 15:45 that Bijoy said, "...you have to insure that after taking away the tax, the money which is left for the lowest earning man [sic] - that it should be sufficient for the daily requirement - for him to lead a", and Kishor finished the sentence: "to sustain himself". Their solution was to pick a low amount of tax, but not no tax at all. They did not mention that there are already many people (women and children as well as men) who do not get enough money to sustain themselves, even without paying any tax.

Actually, the handout had been written ten years before this session, and because of inflation the salaries it mentioned were very low - maybe half of the inflation-adjusted amounts. However, no one pointed this out.. The gap between the rich and the poor has been increasing, and unemployment has been very high and increasing. However, none of the students seemed to have much awareness about how much money poor people earn. T

At 10:40 Bijoy started to say, "So our aim should be such that we should try to equalise - means: who is having less - he should be -" Perhaps he was starting to think about whether fairness includes a sense of economic equality in income - not just the equality of the fixed amount everyone pays as tax.

But this line of thought was diverted into a discussion of what is the total amount of tax the government would collect in each method. They both argued that Method 1 may not be the best because the government could not get as much tax as with Method 3. Apparently they actually did not realise that the number of poor people far outweighs the number of rich people, so the government might get a lot from Method 1.

This is an example of how students cannot do adequate science if they do not observe or have access to observations of physical reality. Apparently, Kishor and Bijoy had not seen the statistics that they needed in order to reach valid conclusions. Leena and Uma also probably did not fully understand that because

the number of poor people is so much greater than the number of rich people, sales tax may be coming mainly from poorer people. Anil and Deepak, coming from poor farming families, had first hand observations (experience) of poverty, so they had a better understanding of who the different taxation methods are fair to.

Reconsidering his point about government requirements, at 18:10 Bijoy said, “you cannot say that the government does not require money Even if the government has sufficient money - if the government can get more money then it can also invest in something -” He kept thinking that the government should get as much as it can. Both Kishor and Bijoy seemed to be seeing things from the point of view of the government. Were they making an analogy between a government collecting tax and a company making a profit? Perhaps this reflects their socio-economic class in a system in which making a profit is the bottom line (and in which it is taken for granted that there is nothing unfair or immoral about the profit motive). The students did not express any general distrust of the government, as might be expected (Salvador Casara et al., 2023).

All the students, as well as the canteen workers spoke about the people, especially the poor people, as being separate, and having different interests from ‘the government’. This is in agreement with other studies that show that students see the government as being an alien power which is beyond their control (George, 2007). It is an accurate perception of reality. It also indicates that the education system, together with the effects of media and other social-political influences have not been able to present a convincing image of the country as a ‘democracy’ in which the people are the government.

At 12:25 K said: “... Suppose that in each case the government gets the correct amount of money - which model is better?” and Kishor replied, “Ok Ok She is saying that assume that in every case the government is satisfied. Okay now, which one would you prefer as a citizen - like which one would you like to have?” However, even after this they did not discount the argument that the government needs more money. At 14:12 Bijoy said “Ah I would say it [Method 3] is fair if you look from the point of view of the government because the government needs money to run the state.”

At 24:20, Karen said, “But it depends on how many people there are in each category. ...Let’s suppose that the total amount [that the government collects] is the same [for each method].”

Then Kishor said, “So what she is telling is that this [poorest] has the most number of people - the frequency of this [poorest] is more and this [richest] is less - so you’re collecting eventually more tax from here [poorest] -so then you have this to be less [people] over here, so I think ...”

And Bijoy took up the same line of thought, interrupting, “then what will happen is then if you count the weighted percentage of salary given as tax, then here [poorest person in Method 1] it is a large fraction compared to this one? ... So here [Method 3] ... the number of people who are being deprived of their money, is comparatively low”.

Then at 26:50, Kishor said, “Ok so what she’s trying to say, suppose there are 100 people, in one model we have 98 people paying tax - collecting x - and in the other model you have 2 people paying tax collecting x.”

But then Kishor concluded, “So then there is no equality if 2 people are paying tax for the whole country-” Even after considering that there are many more poor people than rich people, he had gone back to his previous belief that Method 3 is not fair.

Then Bijoy presented some mathematical calculations of hypothetical cases, for example, comparing

Method 1: ₹50 tax / ₹1000 salary x (a large number of people)

to

Method 3: ₹6000 tax / ₹20,000 salary x (a small number of people).

He said, “their frequency will determine how efficient - which one is a better system.” But Kishor said, “It’s not a question of better - it’s a question of fair.” Bijoy replied, “So it is fair because you naturally wouldn’t like a large number of people being deprived of their salary in your state.”

Bijoy seemed to be trying to calculate whether it is fairer (or better?) to deprive a few people of a lot of money or a lot of people of a little money - or whether it is just a matter of minimising the number of people who pay tax - mathematizing the problem. W

5.3.3 Complaints and Grudges: The fairest method is the one which people will not complain about

Beginning at 15:35, Kishor and Bijoy kept mentioning whether or not people will complain as an indication of whether a method is fair or not. Complaints (or “grudges”) were referred to many times by both Kishor and Bijoy (see Table 1), although at one point (19:45) Kishor said that a lack of complaints does not necessarily mean that a method is fair. At times they seemed to be arguing not about fairness, but simply that a particular method could not be used if too many people complained. They themselves referred to issues of ‘practicality’ in order to gauge fairness. At times they argued that Method 1 would produce complaints (by the poor), and at other times they argued that it would not. At times they argued that Method 3 would produce complaints (by the rich). In the end, Kishor concluded that in any method some class would suffer, so they should look at other arguments.

5.3.4 Equality and Genetic Determinism

Another point when the researchers took a more proactive stance was in order to probe the student’s sense of equality and responsibility. Both Kishor and Bijoy seemed to think that equality is indicated by an equal amount of tax rather than an equal percentage of income paid as tax:

19:50

Bijoy: But you have to make a compromise - if it is fair and - what you need.

Kishor: It depends on what you call fair - it will depend from person to person.

Bijoy: The thing is that this one [Method 1] is the ideology of equality. And this one [Method 3] is ideology of need. So you make a balance between -

Saurav: So you're thinking of equality

Kishor: Equality in collecting taxes - like I am not charging the person more who is earning more - ah

Bijoy: You are considering each citizen as - same unit.

Saurav: So if someone is earning more, and someone is earning less. Who is responsible for that - the one is earning less or more?

Kishor, Bijoy: No one is responsible.

Kishor It is the circumstances which lead to -

Saurav: So it is their real capability - That's why they are earning more - is that right?

Kishor: No it's circumstances - like if given a chance, maybe he can become a businessman ...

Bijoy: But the thing is, that it is built in the human genome because - every person is not equal - so - if you are given a task, both cannot do it with equal efficiency.

Kishor: Yes.

Bijoy: So there is inherently some disturbance in the situation...

Saurav: You are saying that some people certainly earn less money -

Bijoy: will always earn less - This is the division of labour, you can say.

Kishor: It is not possible that there will be uniformity in earning, so - So I would say that [Method 1] is the best, considering the government doesn't need. And if you go for the practical situation, I will definitely go with [Method 3].

It is interesting that Bijoy kept mentioning the importance of equality. But when prodded, he started rationalising inequality on the basis of genetic determinism. Comparing the USA and Europe, countries where people tend to believe that income is determined by luck (rather than hard work) generally have higher and more progressive taxation, and lower wealth inequality (Alesina & Angeletos, 2005). Perhaps this is because people demand progressive taxation. However, here the students are arguing that luck (genetics) results in a situation where inequality is natural and inevitable, so everyone should pay the

same tax. Although, at times Bijoy argued for Method 3 - which he seemed to understand mathematically is a method of equalising unequal incomes.

They tended to see tax as a deprivation or punishment. As Kishor said (at 38:20), “Why not charge everyone? Why make a distinction? Like, it’s not that the person earning more is committing a crime or something. That he has to pay so much amount.” However, they did not see low earnings as a punishment or deprivation, perhaps because low earnings are assumed to be natural.

Thus, Kishor and Bijoy seem to have realised that there is a conflict - although they are arguing for equality, equality can be viewed in two conflicting ways - in terms of absolute figures or percentages. They have to choose one or the other. Consideration of reasons not directly related to equality may have been convincing them to change their minds, as reflected by their statements.

At the end of the discussion, Kishor and Bijoy agreed that they disagreed with each other. However, they agreed that in any taxation method some class has to suffer (poor people suffer with Method 1 and rich people suffer with Method 3). They were not sure whether to take the side of the poor or the rich. Apparently Kishor thought it is more fair if the poor people suffer and Bijoy would rather let the rich suffer. But they did not explicitly state it like this. Instead, Bijoy said that since a fewer number of people will suffer in Method 3 (presumably because there are more poor than rich), it will be better. Kishor said that since in any case some class has to suffer, choose the method on the basis of ‘efficiency’ rather than suffering. They did not explicitly discuss whether people have a right to be rich. They seemed to agree that a person should not be ‘blamed’ for being rich or poor - it happens due to their genes (and perhaps chance opportunities). They did not discuss where wealth comes from or the dependence of the rich on the poor.

5.4 Using questions in argumentation

In Sessions 1 and 2, it was mainly the researchers rather than the participants who asked questions. In Session 3, when the researchers tried to be quieter, the students asked each other questions.

The only type of questions the canteen workers asked were rhetorical questions. Rhetorical questions might have been asked in order to draw the others into the argument. For example, putting himself in the place of a poor person, Anil said “If we only have ₹1000 then how can we pay the tax - what will we have left?”. The use of the pronoun ‘we’ also tends to draw the listener into the argument.

Kishor also used a number of rhetorical questions, for example, at 38:20, “The difference is that, if you are collecting the same thing. Why not charge everyone? Why make a distinction? Like, it’s not that the person earning more is committing a crime or something. That he has to pay so much amount.”

Both Kishor and Bijoy sometimes posed questions which they immediately answered. For example, at 10:05 Kishor said, “What happens if someone earns less than 50? He will be in debt.”

In Session 2, The students asked checking questions in order to check if the listeners were agreeing. For example, Leena asked, “Ah - it’s more about situations, right? It’s not about **their** capability. Some people just get born in a rich family.” And later on, Uma asked, “Government is there to take care of us. Right?” Seeing the researchers as authority figures, the students may have been addressing such questions to the researchers for guidance.

At times, Kishor and Bijoy posed questions in order to define the direction of the dialogue. For example, at 29:15, Kishor said, “It really depends on what is a fair way - fair to whom? Fair to whom?”

Implicit questions are hard to identify, but presumably the discussions proceeded non-stop because the participants kept asking themselves unstated questions. Often they were asked because a conflict was being confronted. For example, Bijoy was probably asking himself the implicit questions, ‘Does the government require more money or not? Why would the government go for Method 3?’ when at 13:40 he said, “... it depends on the philosophy which you are going to follow - If the government does not require the maximum amount of money - The whole point of invoking this type of system [No. 3] is the government wants parity within the population distribution - means, the one who’s earning more and more, the government tries to take more from him.”

When Uma was arguing that the amount of rent someone pays cannot depend upon their income, she said, “No we can’t tell them [the landlords] to change that, because it’s - ah if we are renting something it’s their property. So we can’t - ah - maybe we can try to tell them but we cannot make it a rule that it should be like that because it’s their property...” This sounds like she had asked herself the implicit question, ‘Or could we try?’ But she rejected the possibility, because owning property and paying different rents for different quality homes seems to be the natural order of things.

Kishor asked a total of almost twice as many questions as Bijoy, even though Bijoy spoke slightly more than Kishor. However, in general the conversation was remarkable in that it was very balanced, with both Kishor and Bijoy spontaneously taking turns talking.

5.5 Why did they change their beliefs?

It was only in Session 3 that we saw the participants changing their beliefs in the course of the discussion. They changed their beliefs in many ways and for many different reasons. Changes sometimes happened when one student dropped an argument in which one method was believed to be fair for certain reasons, and began to consider new reasons which supported the other method, even though the old reasons may not have been ‘disproved’. This happened for example, with Kishor at 15:20 – 15:35. when he said: “Considering this hypothetical situation that the government will not require any money, this [Method 1] should be the more or less stable model - or at least a fair way - it may not be stable. ... It may be a fair way. But even then again I think there will be a grudge as we go down the earning state -” Kishor proceeded to argue that Method 3 will be more fair because fewer people will bear grudges. However, he soon (by 17:00) reconsidered Method 1 for the same old reason (because the government may not require so much money).

One of the most important reasons that Kishor and Bijoy changed their beliefs during the discussion was because they became aware of contradictory or conflicting beliefs and wanted to resolve the conflict. The conflicts were not very emotional. They seldom interrupted each other to disagree - but occasionally to finish each other's sentences. Neither Kishor nor Bijoy took the lead or became aggressive, angry, or demeaning. The tone was lively but serious and friendly throughout. There was no sense of competition.

There are several types of conflicts they confronted:

(a) Self-conflict: One student realises "I have beliefs that conflict with each other".

At 14:12 Bijoy says that Method 3 is more fair than Method 1 because the government needs money and cannot take all away from poor people. But then, at 15:15 he says that it is fair for everyone to pay the same price when they buy something like an IIT application form. He thinks that his belief that poor people should not pay as much tax as rich people conflicts with his belief that it is ok for poor and rich people to pay the same prices for things they buy. This conflict causes him to (temporarily) change his belief and resolve the conflict by saying that Method 1 is more fair.

An example in which Kishor changes his belief due to a self-conflict is at 30:15, when he says that in Method 1 a large number of [lower class] people will be having a grudge because they will have to pay tax. But then (after Bijoy says, "yes") Kishor immediately says "But I don't think that they'll be having a grudge - if they are charged the same amount." He realised that they will all be treated equally because they are all paying the same amount of tax, even though they will not be paying the same proportion of their income. There is a conflict - he has to decide whether the people will consider paying equal amounts or equal proportions as equality, and he decides to go with the former. He resolved the conflict by giving up his belief that they would be having grudges, and he says that Method 1 is fairest.

Interestingly, most of the changes in belief which we saw in Session 3 were due to realisations of self-conflict. In some cases both students faced the same inner conflicts around the same time, which is evidence of a synergistic effect. Because of this, and because the students worked collaboratively to solve the self-conflicts, we think they can be called dialogical socio-cognitive conflicts.

(b) Inter-student-conflict: One student realises "The other student has beliefs which conflict with my beliefs."

In each of our sessions, the participants were friends coming from similar backgrounds. We therefore expected fewer conflicts than might arise if the participants had vastly different points of view. However, we did see numerous expressions of conflicting beliefs in Session 3. Obviously this would not have happened in a usual classroom in which students do not get chances to talk to each other. Perhaps because Kishor and Bijoy were friends, they did not want to disagree with each other. This may have contributed to their persistence in trying to resolve any conflicting beliefs which arose. These types of conflicts are obviously dialogical socio-cognitive conflicts.

At 20:45 Kishor said he believed that the reason why one person earns more and another person earns less is just circumstances, not real capability (see above, Section 5.3.4). But this conflicts with the belief of Bijoy that it is built into the human genome that all people cannot do things with equal efficiency. In response, Kishor apparently changes his belief and agrees with Bijoy.

Another conflict between Kishor and Bijoy may be that Kishor believed it is unfair to deprive a few people of large amounts of their earnings, but Bijoy believed that it is wrong to deprive many people of small amounts of their earnings. However, this conflict was never stated very clearly by either of them.

(c) Conflict with authority: A 'teacher' (or textbook or some other source of authority) presents a conflicting belief (not necessarily because the teacher really holds the belief).

At 24:12, the researchers expressed their opinion that the total amount of tax collected in Method 1 would not be less than in Method 3 because there are many more poor than rich people. This conflicted with what Kishor and Bijoy had been saying (that the government could not collect as much money with Method 1). The conflict led them to become confused and vacillate between saying whether Method 1 or 3 was better. They did not completely accept what the researchers were saying, and they kept prefacing their statements with statements like, "So what she's saying is" or "If you consider that the amount of money the government collects is the same in each case..." .

(d) Conflict with Observations: One or more students realise that they have beliefs which contradict with an observation of physical reality.

In our sessions, none of the participants made their own direct observations - unless we consider their calculations based on the given examples to be observations. However, occasionally someone referred to what might be a remembered observation, or a prediction of an observation, in order to give evidence. And sometimes an observation contradicted a previously stated belief, leading a student to change their belief.

At 24:20, Karen asked Kishor and Bijoy to assume that the numbers of poor and rich people are such that the government could collect the same amount of money with Methods 1 and 3. Kishor then said, "So what she is telling is that this [poorest] has the most number of people." Although he did not make the observation himself, this was an observation of physical reality. It led Kishor to (temporarily) change his mind and conclude that Method 3 is not fair because, "there is no equality if two people are paying tax for the whole country". Perhaps it would have had more impact if they had made their own observations - by looking at census data, for example.

(e) Hearing about conflict: Someone else mentions conflicting beliefs and the student asks, "Am I having analogous beliefs?" and "Which side am I on?"

At 16:10 a researcher (Saurav) raised the point that different classes of people may have conflicting beliefs about fairness: "The question is - about fair. Now, fair to whom? Is it fair for government? Is it fair

for citizen? For example when you talk about fair, is it fair for the person who has earning of 20,000? Or is it fair for all? Or is it fair for low income people?"

It was only after this that either Kishor or Bijoy mentioned that different classes may have different conceptions of fairness. But it did not happen immediately. First, Bijoy continued talking about his IIT form analogy which he had mentioned earlier, and they both returned to their discussion of the needs of the government. Then at 19:55, Kishor said, "It depends on what you call fair - it will depend from person to person." The conversation again got diverted, only returning to this point again at 23:35 when Kishor said, "We would definitely go for this one [Method 3] because this - I think maximum number of people wouldn't have any complaints - especially the lower earning people, if they have to pay very less." By 29:30, Kishor seemed to have understood the importance of conflicting beliefs of different classes (not just individuals), using almost the same words Saurav had used: "It really depends on what is a fair way - fair to whom? Fair to whom? Fair to the government? Fair to the people? Fair to the lower class of society? Fair to the higher class of society?" Finally he changes his mind, siding with the wealthy against Method 3 because "they will complain that we are paying all the taxes for the state. Considering that - [Method 1] would be a better way - like, no one has to pay for the entire thing or something like that ". Apparently Kishor changed his belief because he was influenced by the researcher having mentioned the conflicting beliefs (although he did not choose the side the researcher would have liked him to choose). However, this was very transitory - at 31:45, Kishor went back to saying that Method 3 was more fair, for different reasons, and his beliefs continued to fluctuate. Although here both 'they' and 'we' are used to refer to rich people, the students' more frequent use of the pronoun 'they' to refer to poor people indicated their point of view.

(f) Conflicts that do not result in a change in belief

Sometimes the recognition of a conflict did not result in any change in belief. When the researchers asked Leena which of the three income tax methods is more like sales tax (indirect tax), she realised that it is more like Method 1, which could be called an observation of physical reality. But she had already said that sales tax is more fair than income tax, and she had decided that Method 3 is more fair than Method 1. This was a conflict between her belief and her observation, as well as a conflict between her own beliefs. But she did not resolve the conflicts by changing her belief that sales tax is fair, or that Method 1 is not fair. She resolved them by rationalising that poor people do not buy the same things as rich people (luxury items, which have higher tax), so they do not pay as much sales tax. They did not question the inequality that results in a minority that have luxuries.

5.6 Kinds of reasoning and argumentation

Many researchers (Erduran & Jiménez Aleixandre, 2008; Nielsen, 2013) have pointed out the drawbacks of using the Toulmin model (Toulmin, 1988) of classifying elements of arguments as claim, data, warrant, backing, qualifier, and rebuttal. Questioning, which we found to be very important, is not included. The Toulmin model seems to describe a war or competition (Muller Mirza et al., 2009) rather than the more collaborative argumentation we witnessed in which people try to help each other

understand. As Nielsen points out, the Toulmin model does not adequately describe the dialogical nature of students' argumentation. The argument between Kishor and Bijoy could be considered to be an example of this dialogical nature in which "students collaboratively manage (potential) disagreement by providing arguments and engaging critically with the arguments provided by others" (Nielsen, 2013). Dialogical argumentation does include questioning and requesting justification. However, Nielsen does not mention that in dialogical argumentation, one person may argue with themselves - the "self-conflict" argumentation we mentioned above.

The students used a wide variety of reasoning to form and defend their beliefs. In their arguments, we have found examples of four main types of reasoning: (1) Analogies; (2) Arguments based on observations (or predictions of observations); (3) Deductive arguments based on a general world view, moral or social value; (4) Inductive arguments based on specific examples; and (5) Inferences. Examples of each of these are given in Table 2.

Table 2
Types of Reasoning which participants used in arguing about which method of paying income tax is more fair

Analogies **It's like people of different heights standing on different size blocks to be able to see over a wall.** **Paying tax is analogous to buying IIT forms, or buying anything.** **Paying tax is analogous to paying tips.** **A few paying high tax is analogous to a few people feeding the whole state.**
Arguments based on observations (or predictions of observations) **If we see many people complaining, the method is probably not fair.** **Rich people have so much money that they cannot use it all for their personal needs, so therefore they can afford to pay higher tax.** **Poor people may not have enough money to sustain themselves - so therefore they cannot afford to pay tax.** **The government needs money, so they should use the method that gives more money.** **If we see practical problems (e.g. it is complicated to collect tax) then the method is not worth considering.**
Deductive arguments based on a general world view, moral or social value* **Equality is desirable, so the fairest method will be the one that treats people equally.** **We should try to equalise the amount of money people have (reduce class division), therefore the method that does this is more fair.** **People are different (there is unavoidable (genetic) inequality), therefore we should not worry about equality when evaluating fairness.** **Sharing is desirable, therefore everyone should contribute tax.** **People have a fundamental right to private property and to acquire money and get rich, so taxation should not counter this right.** *** Of course, the premises upon which deduction is based may also be based on inductive reasoning and observations**
Inductive arguments Jyoti has trouble feeding her children and paying tax, so other poor people will also have trouble. Jatinder has enough for all the basic necessities after paying tax, so other rich people will also. If one person paying a large amount of tax is having a grudge, everyone paying a large amount will have a grudge.
Inferences If the fixed amount of tax is low enough, everyone can pay it.

Some people cannot afford to feed their family, therefore they cannot afford to pay tax.

No one has grudges against it, therefore the tax method will be practicable.

We found that even after engaging in critical analysis using various types of reasoning, the participants may have believed that Method 1 is more fair than Method 3. This implies that wealth inequality is acceptable, which is against the UNSDG. However, it is in line with the views put forth by the super-rich, who have inordinate power to prevent progressive taxation, even if their beliefs are irrational.

The discussions were limited to a considerable degree by the students' experience. This can be seen, for example, in their use of analogies to buying forms and paying tips at hotels, two situations they are apt to be more familiar with through their own personal experience. However, since Bijoy was not of the category that receives concession on IIT application forms, it seems that he thought everyone pays the same amount, and no one complains about it because it is a small amount.

Reasoning based on observations is perhaps the most important type of reasoning used in science (or social science). That both sets of students used many arguments of this type may indicate that they were 'being scientific'. The workers also used this type of reasoning, referring directly to themselves as examples of poor people not having extra money.

Reliance on deductive arguments such as those shown above may be considered to be less 'scientific' - unless the premises are supported by observations.

6. Conclusions

We were trying to find out people's beliefs on taxation methods and how they can be taught to use proportional reasoning to advocate progressive taxation for alleviation of inequality.

All the participants in all three sessions filled in the numerical answers on the handout correctly, indicating that they had a good, working understanding of proportional reasoning. None of them wrote anything that indicated they were robotically following the step-by-step procedure taught in school. They mentally did whatever calculation that was required. They applied their proportional reasoning to the problems of inequality and taxation in different ways.

It was only in Session 3 that we observed belief change. In this session, the students kept changing their beliefs as they encountered conflicts with themselves, with each other, with authority, and with observations. They also changed their beliefs upon hearing about conflicting beliefs. This leads us to wonder whether teachers should purposely introduce contradictory statements or anomalous data in order to facilitate change in students' beliefs, as discussed by Limón (2001).

6.1 Comparing income tax to coffee and milk

If the students thought of equality as a measure of fairness, they had to decide whether equality should be measured by a fixed, equal amount of tax or by equal or variable proportions of each person's income. To make an analogy to the problem posed by Eleanor Duckworth, we can consider income to be coffee and tax to be milk. The question is whether adding one spoon of milk to a small cup of coffee will have the same effect on the coffee as adding one spoon of milk to a large cup of coffee. This is analogous to the question of whether subtracting ₹50 from an income of 1000 will have the same effect (on income) as subtracting ₹50 from an income of ₹20,000.

For both of these questions there is just one correct answer. The effect of adding one spoon of milk depends on the amount of coffee we are adding it to. Similarly, subtracting ₹50 from an income of 1000 has a much larger effect on the income than subtracting ₹50 from an income of ₹20,000. This is 'the correct answer'. The effect of deducting a fixed amount from the income of different people does not have the same effect on them if their income is very different - and people do have very different incomes.

However, the concept of 'fairness' is much different from the concept of 'milkiness'. Not everyone will agree that it is unfair or less 'equal' to deduct ₹50 from all, even if they realise that the effect on a small income will be greater. 'Fairness' is much more complex than milkiness since it includes many social aspects in addition to the more mathematical aspects of equality and proportion. Whether equality is a measure of fairness is debatable. Also, while equality of milkiness is a matter of proportion, it is not clear whether equality of income tax should mean equality of tax collected or equality of effect on income (i.e. proportion). Questions of ethics and ideology obviously arise in the case of income tax. It also involves defining and evaluating the concept of fairness, and deciding whether reducing economic inequality is desirable.

In the study by Salvador Casara et al. (2023), 2119 people were asked (using a Likert scale) questions about inequality and taxation. For example, they were asked whether they thought rich people should pay more taxes than others. Their answers were correlated with self-perceived economic status, income, political orientation, and other characteristics. The results led to some very interesting conclusions. However, based on the discussion we recorded in Session 3, we wonder whether people can really give meaningful, stable answers to such questions, or if they think and discuss with each other for half an hour or so, their opinions will keep changing.

6.2 Argumentation and questioning

At what stage did each participant realise that there is a difference between subtracting fixed amounts and subtracting proportions? Apparently, in Session 1, Anil and Deepak realised it immediately. In Session 2, Leena and Uma also realised the difference within the first few minutes, albeit only after prompts from the handout and the researchers.

We might think that if someone has a good understanding of fractions, proportions, and mathematics, as Kishor and Bijoy did in Session 3, they will be likely to quickly realise that paying proportionate or fixed

amounts of income tax will have very different effects on rich and poor people. However, it took them quite a while to say this. We suspect that this is because they were not thinking from the point of view of the poor. They did not immediately mention the human angle of the problem, or how difficult it would be for a poor person to pay any tax at all. They later mentioned “not being able to sustain”, if the difference between income and tax was zero or less. This was the difficulty that Uma expressed at the very beginning, perhaps because she had the handout with the parts in italics that suggested that, “Jyoti cannot even afford to feed her children properly.”

Is it better to use the full text version? Leena and Uma had seen the longer version, and chose Method 3, but they did not realise that sales tax is a regressive form of tax just like Method 1, which hurts poor people disproportionately. This makes us wonder whether their answers were swayed by thinking that Method 3 is the ‘correct’ answer that the teacher is demanding, rather than by a deeper understanding. Would it help if textbooks gave more stories of the lives of real people? Research in the USA indicates that after studying explicitly about poverty, including through examples and statistics, elite students showed greater recognition that factors outside an individual’s control can cause poverty (Mistry et al., 2012).

Although in Session 1 the canteen workers chose Method 2 (Fixed Proportion), they thought Method 3 (Variable Proportion) was also ok, but was impractical from the point of view of poor people. They did not reconsider or change their minds (although the session was unfortunately cut short because they had to go back to work). They focussed their attention on ethics and practicality.

In Sessions 2 and 3, all the students initially chose Method 3 (or a slightly modified form of it) as being best. As teachers trying to encourage students to learn that a proportional method of collecting income tax is more fair, we might have thought that we had succeeded after the first two or three minutes of each session when all the participants rejected the flat, fixed amount of tax (Method 1). But actually, they may not have learned anything - they may have had the same beliefs before we interacted with them.

It was only when we heard the rest of the discussions that we realised that the students may not be fully internalising this opinion. In Session 3, o Kishor and Bijoy continued to keep changing their beliefs, and did not seem to arrive at a definite answer even at the end of their discussion. Even though they did not come to strongly believe in progressive taxation to fight inequality, we think the abbreviated version of the handout may be better because it did seem to encourage deeper discussion.

In the typical classrooms that we have observed in several parts of India, rather than carrying on discussions with each other, the teacher does most of the talking, and when an enquiry mode (Chin, 2007; Minner et al., 2010) is being used, there are dialogues between the teacher and one student at a time (Singh et al., 2019). Ordinarily the teacher asks the students questions for which the teachers already know the answers, and the students give the answers that they think the teacher wants. (Mehan, 1979) calls this the IRE triad: teacher Initiation (often a question), student Response, and teacher Evaluation or Elaboration. This process is not very conducive to engaging the students in analysing or questioning their own beliefs, especially for issues such as inequality and social justice. Other

researchers have also pointed out that even at the undergraduate level, classrooms do not provide students with much time or space for questioning and arguing (Butera et al., 2010). Students are socialised to conform to their teacher's view (Dambrun et al., 2009).

In the first two sessions the researchers asked questions, but they did not give evaluations of the students' responses, except perhaps implicitly by facial expressions, gestures, and follow-up questions. They were using a 'devil's advocate' mode, rather than a typical IRE mode.

In Session 3, the researchers tried to be quieter, although they did use the devil's advocate mode at times. The students did most of the talking, and they both asked, answered, and evaluated each other's questions. As we have found in other research also, when teachers ask fewer questions and speak less, students ask more questions and have more discussions with each other (Singh et al., 2019). We think this is more conducive to effective learning.

In Session 3, the students asked each other many types of questions: rhetorical questions, checking questions, and implicit questions. Except for one procedural question (when Bijoy asked for a sheet of paper), the students did not ask the researchers any questions. They never asked the researchers what their opinions were, indicating that they accepted the researchers as teachers or interviewers, not as equals in the discussion.

On their own initiative, the participants used various kinds of reasoning: analogic, deductive, and inductive, as well as arguments based on inferences and observations of physical reality. However, their observations and knowledge of taxation and the economy were lacking. They could have benefitted if they had access to statistics, measures of inequality, and data regarding the economy and taxation. They were clearly guided by their own experience, using examples from their own lives and points of view. This supports our view that teachers should rely on students' experience, as well as on trying to widen their perspectives by presenting data and discussing other points of view.

None of the students in our study seemed to be aware of how much income poor people actually have and how they survive even without paying tax, Neither did they realise how many more poor people there are than rich people. They never mentioned the huge amount of inequality. Neither did they seem to realise that this inequality is due to capitalism and is not inevitable. It seemed natural to them that poor people cannot have 'luxuries'. None of the participants in any of the sessions discussed the problem of avoidance and evasion of tax laws, although practical problems of implementing Method 3 were mentioned in Session 1, and implied when Kishor started to talk about fooling the system, and when grudges were discussed in Session 3.

Kishor and Bijoy apparently based their beliefs on their own experience and observations - they probably did not have much experience of poverty - they spoke of purchasing IIT forms, paying tips in hotels, and the whole question of fair taxation seemed to be largely a question of mathematics.

Rather than (or in addition to) the text in italics, maybe what the students needed was some statistics on how much different classes of people earn and how much wealth they have. The government of India has been reluctant to release such statistics. Maybe knowing the statistics are crucial to changing people's beliefs about inequality. Maybe some of their acceptance of regressive taxation was due to their insufficient experience and observation.

6.3 Should teachers encourage students to change their beliefs?

As in an enquiry mode of teaching, the researchers asked questions either in order to find out what the students thought or to help the students develop lines of discussion and reasoning. The researchers avoided explicitly telling the students what they thought the answers should be, except to check their calculations when they first filled in the blanks. This is in line with the common teaching practice in which, if teachers think the question is a matter of opinion rather than 'fact', they avoid explicitly stating whether they think the students are right or wrong.

This leads us to the question of our own teaching objectives. Helping poor people take sides with poor people - understanding their position and the reasons why they are poor and their human rights - is a worthwhile goal, in line with the UNSDG. But it may be problematic to try to get rich people to side with poor people, since it does not seem to be in their interest.

As we have discussed, Kishor and Bijoy did not appear to have a deep understanding of the hardships of being poor. In the beginning they thought of the mathematical representations of the problem rather than the sopoec problems. They saw the problem mostly from the point of view of the government - and the wealthier people. The problems of poor people were considered mainly as the problem that poor people would "complain" or have "a grudge" rather than that they would suffer from a lack of food, water, and shelter. I

This raises the question of whether people just assume the ideology of their class. If so, then what is the role of education? Can a teacher really help wealthy students to understand the plight of the poor? And will change come from a change in heart by the rich and powerful? As Frederick Douglas said,

"The whole history of the progress of human liberty shows that all concessions yet made to her august claims, have been born of earnest struggle. ... Power concedes nothing without a demand. It never did and it never will. "(Douglass & Blassingame, 1979).

Nevertheless, education has an important role to play in countering class segregation and exclusiveness, where "one group has interests 'of its own' which shut it out from full interaction with other groups. ... isolation makes for rigidity and formal institutionalizing of life, for static and selfish ideals within the group" (Dewey, 1915). Our study is an attempt to counter this isolation and encourage students to confront class conflicts as they discuss taxation.

Many educationists claim that all sciences are “value laden”. Some say that the ideal teaching method is to “expose students to the various ways that values apply to science and help them develop skills in distinguishing their differences and in analysing the role of values in producing particular facts” (Allchin, 1999). As teachers we often try to “be objective” and “present all points of view” so that students can “decide for themselves”. If an individual’s decisions actually depend on their social environment, and if it is impossible to present all points of view, and if objectivity in science is not possible because science is value laden, then what are we to do? And despite a teacher’s intentions, won’t students sometimes be developing skills to mimic the teacher’s values - or to mindlessly rebel against them?

Even if we cannot very successfully teach compassion, we can at least aim to help students be more explicitly aware of themselves, their own points of view and their interests, and to see that their interests are not the same as the interests of other classes of people. In other words, maybe a goal of teaching, including teaching elite students, is to try to make the contradictions more visible. In this paper we have presented an example which indicates possible routes towards such teaching/learning.

Was it right that we did not give our own opinions in a very straightforward way - but only by implication? And was it right for us to be playing the devil’s advocate?

One could argue that we were just confusing the students. On the other hand, if we think that learning means changing beliefs and asking questions, perhaps a teacher should try to confuse the students so that they confront conflicts and ask themselves authentic questions, which may lead to changing beliefs.

Or, perhaps it is better if students confuse and conflict with each other. The participants in Session 3 may have been encountering epistemic conflicts, changing their beliefs, and influencing each other because they were arguing mainly with friends, rather than with a researcher/teacher (in which case relational conflicts with authority figures may have been present).

Based on the more highly engaged student questioning we observed in Session 3, compared to Session 2, we think it was better for the researchers/teachers to ask fewer questions and be quieter. Students should be the main ones asking questions, not teachers, and it seems that students do ask themselves lots of questions when there is not much input from a teacher. Probably giving students the handout with less text also led to more confusion and questioning by the students.

Some might say that our last approach was best because we did not try to press our own beliefs onto the students as much as we did in the second approach. If you believe that learning can and should be done in an objective manner, then maybe this last approach is more appealing.

We think we avoided indoctrination in our sessions by encouraging students to question what the text and the researchers/teachers said - even though we did advocate a particular point of view. We hoped that through questioning and critical analysis, students may have come to believe in reducing inequality. Some may think this is a radical opinion - albeit the opinion adopted by the United Nations.. But it does

not call for indoctrination. Teachers can try to avoid indoctrination by facilitating group work that is not dominated by a teacher, and by making sure that students are actively questioning.

The changes in beliefs which we have documented appear to be mainly transitory. Should they be called 'learning'? Does a belief have to remain intact for some time in order to say that learning has occurred? This study supports our belief that beliefs are constantly changing and learning is a process in which experience, actions, observations, questions, and beliefs keep interacting, affecting each other, and evolving.

Although the initial question was posed by the teacher (or the textbook), in the ensuing discussion the students asked a number of authentic questions. We conclude that this exercise has been very successful in its objective of encouraging people to question, analyse, challenge, and possibly change their own beliefs through dialogue with each other and with themselves.

Declarations

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Figures

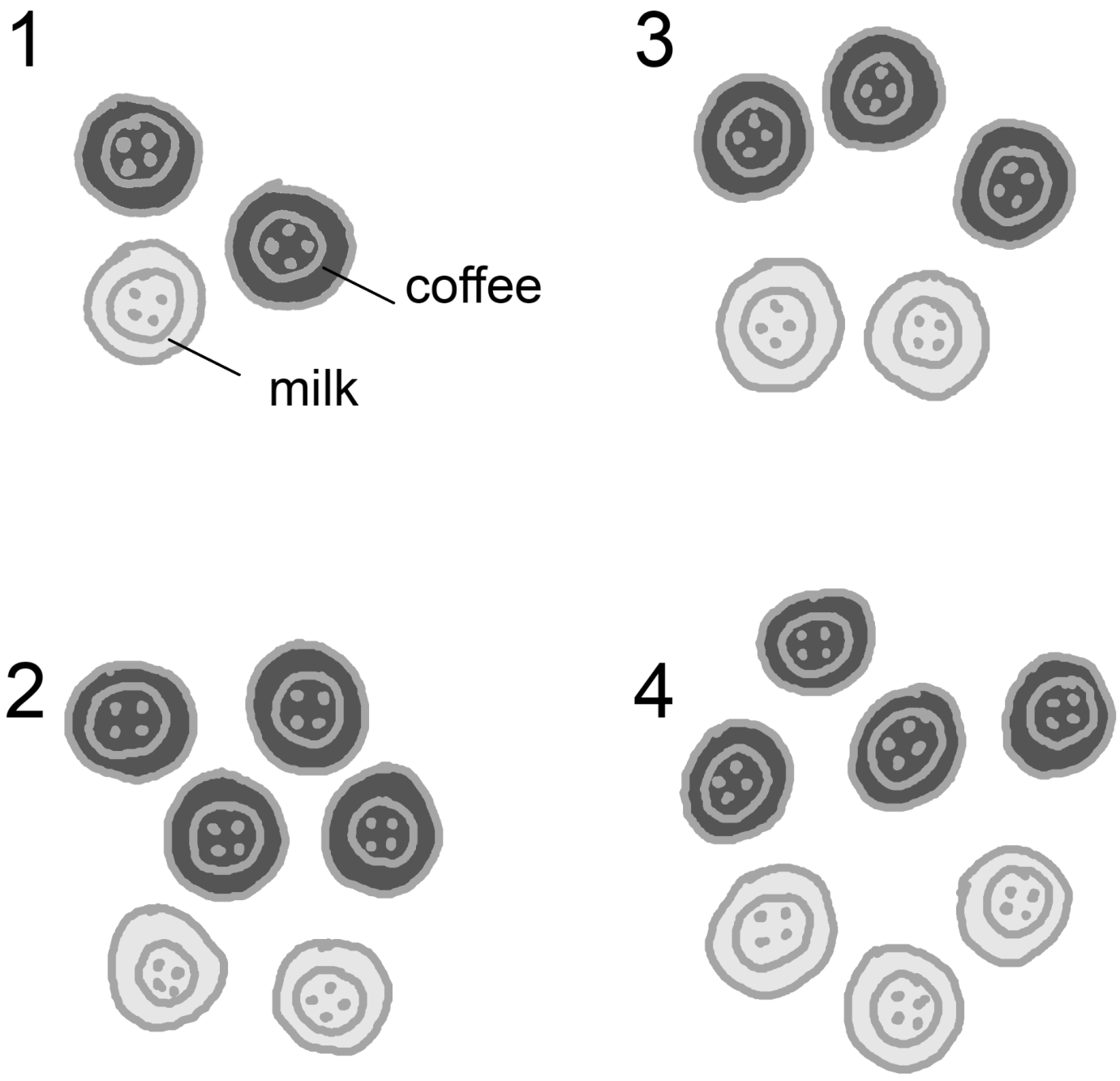


Figure 1

Which cup of coffee is milkier? The buttons represent the relative amounts of coffee and milk in each of four cups.

What is a fair way of collecting
INCOME TAX?

1. **Fixed Amount:** *You might think it would be fair for everyone to pay the same amount of tax. Would it really be fair if each of the following three people has to pay the same amount?*



Person	Work	Earning (per month)	Tax as fixed amount (per month)
Jyoti	Daily wage labourer	1000	50
Asif	School teacher	6000	50
Jatinder	Business person	20,000	50

If Jyoti cannot even afford to feed her children properly is it fair for her to pay Rs 50 as tax?

2. **Fixed Proportion:** *You might think it would be more fair to ask each person to pay a certain percentage of what they earn. Supposing everyone paid 10% in taxes. Calculate how much each person would pay.*



Person	Earning (per month)	Tax as a fixed proportion (per month)
Jyoti	1000	
Asif	6000	
Jatinder	20,000	

Would this be fair? Still Jyoti may not have enough to live on. Asif may not have enough to repair the house. But even after paying 10% in taxes, Jatinder would have plenty of money for all the basic necessities.

3. **Variable proportion:** *To make taxes more fair you might then say that only people earning more than a certain amount, say 4000 per month, have to pay taxes. You might also say that the richest people should pay a greater proportion of their earnings.*

For example:

If you earn	You will pay as tax
Less than 4000	0%
4000 to 5000	10%
5000 to 15000	20%
More than 15000	30%



Use the above Table to calculate how much each person would then pay.

Person	Earning (per month)	Tax as a variable proportion (per month)
Jyoti	1000	
Asif	6000	
Jatinder	20,000	

Would this be fair?

Figure 2

The fair tax handout from the exercise in the textbook (Eklavya, 2004, page 77).

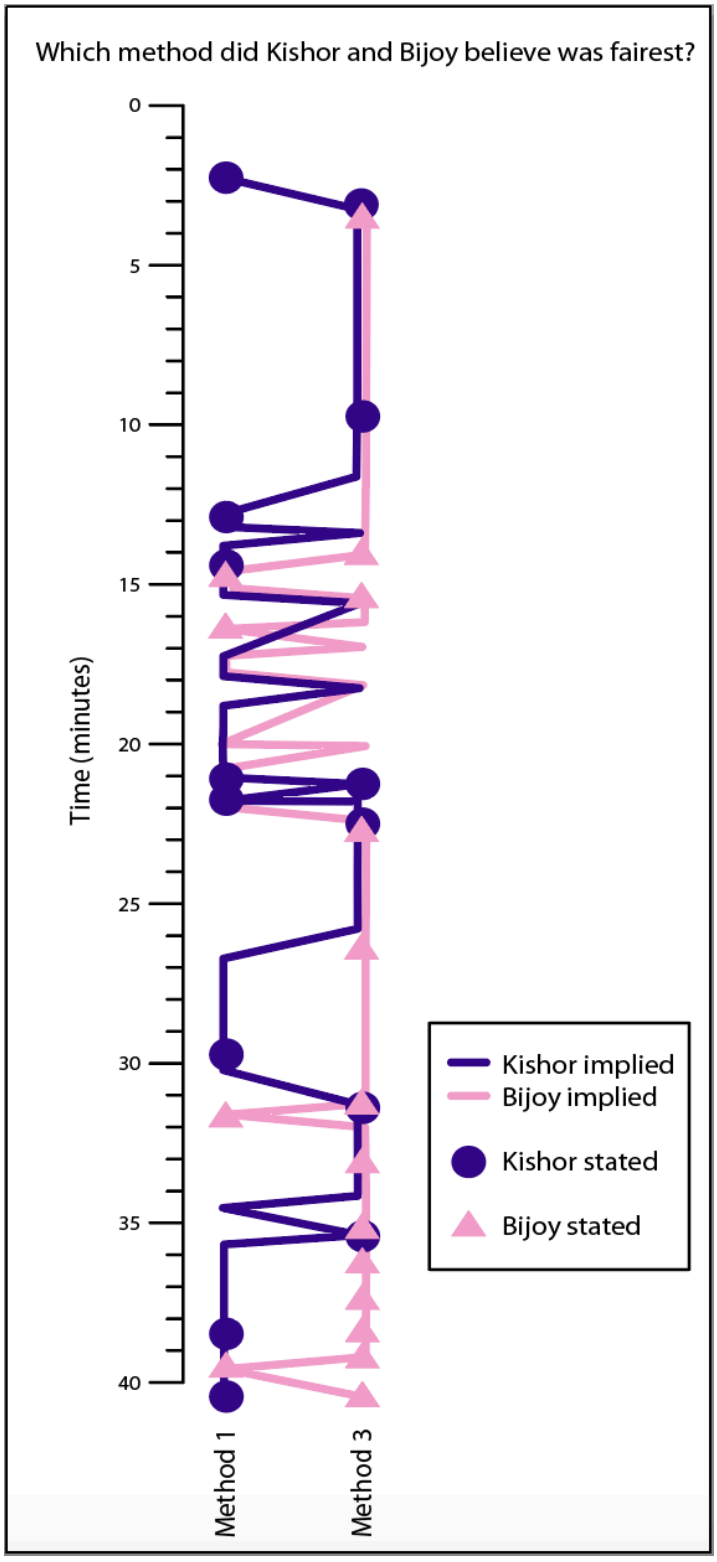


Figure 3

A pictorial representation of the changing beliefs expressed by Kishor and Bijoy throughout their conversation. This shows how they kept changing their stances as to whether Method 1 or Method 3 is fairest. They never explicitly considered Method 2 to be most fair. The positions of the lines connecting the dots are according to our subjective analysis of the conversations, and subject to our misinterpretation.