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# Stickers to Facts, Imposers, Democracy Advocators, and Committed Impartialists: Preservice Science Teachers' Beliefs About Teacher's Roles in Socioscientific Discourses

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**Abstract** For science teachers using the discourse of socioscientific issues (SSI), it is important to make a decision as to whether when and how to disclose their own positions. The existing limited literature shows that science teachers prefer one of four roles during SSI discourse: sticker to facts, imposer, democracy advocator, and committed impartialist. The purpose of the present research is to understand the nature of preservice science teachers' (PST) beliefs underlying such selection. Based on existing literature, we developed a teacher's belief questionnaire including vignettes representing four teacher's roles in discussion of genetically modified (GM) foods. Three hundred twenty-four (324) PSTs from a Turkish context experiencing SSI-based reforms completed these questionnaires, selected one of the teacher's roles, and justified their selection by writing reasons. Content analysis procedures were used in data analysis of this qualitative study. The results show that most PSTs selected dialogical roles (democracy advocators and committed impartialists). Looking at their beliefs, epistemologies and teaching goals work together in PSTs' selection of their preferred role. In addition, we argue that there is no desired alignment between

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teachers' existing beliefs and expectations of SSI reforms. We conclude by indicating certain implications that may enhance such alignment.

**Keywords** Discourse · Preservice science teachers · Socioscientific issues · Teacher's role

## Introduction

In the global competition, many countries invest in innovative projects aiming at state of the art scientific developments and technologies. Due to their economic potential, for example, gene technologies, new energy types, and space research have been given particular attention (European Union (EU), 2012). The developments in these socioscientific issues (SSI) are usually the result of the collaboration among the politicians (goals), the scientists (processes), and the engineers (products). Considering recent cases such as closing nuclear plants in many countries, unless this collaboration takes the public (users) into account, it is clear that these developments are vulnerable to the collapse. Therefore, many governments have initiated not only to support these technologies but also to enhance public understanding by incorporating these issues into school curricula (EU, 2012).

SSI are controversial and include limited scientific evidence. There are disagreements about these issues among the public and even among the scientists. Therefore, teaching these issues is different from many other science topics such as respiration, buoyancy, and periodic table (Zeidler & Nichols, 2009). In SSI teaching, the scholars (e.g. Ratcliffe & Grace, 2003) suggest discourse-based activities aiming at discussing different points of views, producing arguments, and exchanging ideas. However, one of the challenges of SSI discourse to science teachers is whether to disclose their own positions (e.g. Simonneaux, 2007). Should I stick to the facts without entering the world of values and beliefs? Can I impose my personal opinions on the students? Should I bring all positions from different stakeholders into the classroom without explicating my own ideas? Can I succeed both producing a democratic environment and expressing my personal opinions without imposing them on the students? Previous research (e.g. Oulton, Dillon & Grace, 2004) shows that the answers of these questions produce different profiles of science teachers such as stickers to facts, imposers, democracy advocators, and committed impartialists. Even though we are aware that science teachers take one of these roles during SSI discourse, we do not clearly know the underlying mechanism of their selection. We investigate this mechanism using qualitative measurement tools within the present study. In addition, we study in a Turkish context where SSI-based reforms have recently been implemented in national science curricula.

In the following conceptual framework, we focused on teacher's beliefs, classroom discourse types, and the teacher's roles in these types in the initial section. Then, we narrowed our focus by engaging in the roles of teachers in SSI discourses. In the final section, we proposed the rationale of the present study.

### Teacher's Beliefs

Rokeach (1968) defines belief broadly as "any simple proposition, conscious or unconscious, inferred from what a person says or does" (p. 113). Teachers develop

beliefs about (a) self, (b) context or environment, (c) content or knowledge (epistemologies), (d) specific teaching practices, (e) teaching approach, and (f) teacher's roles (Fives & Buehl, 2012). The last group of beliefs is particularly important for the present study. In the context of SSI discourse, we sought to understand the nature of PSTs' beliefs about teacher's roles in the present study.

## Classroom Discourse and Teachers' Roles

Vygotsky (1968) emphasized the importance of language in learning environments by arguing that children grow in relation to the intellectual environment around them. Consistent with this argument, language is increasingly considered the primary mechanism for learning (Reznitskaya & Gregory, 2013). Particularly, classroom discourse is an important component of recent reform efforts in different disciplines of subject matter education (Jimenez-Aleixandre & Erduran, 2007). In general, classroom discourse is based on two types of interactions: monological and dialogical (Nystrand, Gamoran, Kachur & Prendergast, 1997). As showed in Table 1, the paradigm, epistemologies, and teaching objectives vary in these interactions.

In terms of paradigm, recitation is preferred in monologically organized discourse. Recitation is preferred by most teachers who rely on question-answer-evaluation (QAE) sessions (Lemke, 1990). In this teacher-directed format, the teacher asks a question, a student answers it, and the teacher then evaluates whether the answer fits the scientific knowledge prescribed in the curriculum (Lemke, 1990). On the other hand, discussion paradigm is adopted in dialogically organized discourse. The main goal of this paradigm is not to converge upon a narrow set of right answers; rather, it is to uncover, examine, and evaluate diverse answers and perspectives possessing varying levels of correctness (Scott, Mortimer, & Aguiar, 2006).

Epistemology deals with the nature of knowledge and knowing (Hofer & Pintrich, 2004). People develop different types of epistemological beliefs. Kuhn (2001) described three hierarchically ordered stages of epistemological development: absolutist (knowledge is certain and is given by authorities), multiplist (knowledge may include uncertainties and many people have different opinions), and evaluatist (knowledge is contextual and expert opinions can be evaluated and compared based on arguments and evidence). These epistemologies are crucial dimensions in the organization of discourse because teachers with different epistemologies will respond differently to children and organize instruction differently (Hofer & Pintrich, 2004). For example, the teachers with absolutist and multiplist epistemologies prefer monological discourse. They value a single truth and intend to organize their instructions around delivery of facts and

**Table 1** Key features of monological and dialogical discourses in instruction

| | Monological discourse in instruction | Dialogical discourse in instruction |
|---|---|---|
| Paradigm | Recitation | Discussion |
| Epistemology | Knowledge as a given by a valued authority | Knowledge emerges from interaction of voice |
| Teaching goals | Reaching truths by indoctrinating | Co-constructing meanings and decisions |

We prepared Table 1 by slightly changing the arguments of Nystrand, Gamoran, Kachur and Prendergast (1997)

correction of any errors. On the other hand, teachers with evaluatist epistemologies prefer dialogical discourse. They share their authority with students, invite greater student participation, and are open for multiple perspectives (Johnston, Woodside-Jiron, & Day, 2001).

Teaching goals are another important dimension in the management of discourse. In monological discourse, the main goal is typically to reach absolute truths existing in textbooks. Proponents of monological discourse usually prefer noncontroversial issues. If they introduce such issues, they try to display their personal opinions as correct and accepted facts by using indoctrination. On the other hand, teachers with constructivist goals usually prefer dialogic discourse in which they try to co-construct meanings and decisions with students in order to enhance students' higher order intellectual skills (Reznitskaya, 2012).

## Teacher's Roles in SSI Discourse

SSI discourse involves teachers and students investigating SSI controversies and competing scientific claims by using critical evaluation and debates (Sadler, 2011). It is based on the communicative virtues and modes of thought associated with reasonable disagreement (Levinson, 2006). SSI discourse can be realized by socio-moral discourse, argumentation, debate, discussion, or critical thinking activities (Zeidler & Nichols, 2009). In all types of these discourses, students gather, interpret, and consider evidence of multiple defensible positions as well as engage in dialogical activities. Scholars (e.g. Zeidler & Nichols, 2009) believe that science teachers should use dialogical discourse by encouraging students to consider evidence-based arguments and produce counter-arguments demonstrating understanding of opposing positions. Science teachers also need to rely on research and current information about a given topic to better direct classroom discourse through various lines of reasoning (e.g. epistemological, moral reasoning, etc.). In the organization of SSI discourse, science teachers should also benefit from argumentative operations (i.e. structure of argument) and epistemological operations (the nature of knowledge, knowledge sources, etc.) (Jiménez-Aleixandre, Rodriguez, & Duschl, 2000).

Even though SSI studies described above suggest that science teachers with a particular epistemological orientation and pedagogical artistry can reach desired outcomes of dialogical discourse, looking at empirical work on teacher's role in SSI discourse, we see that certain science teachers struggle to adopt such sentiments. The literature shows that there are four types of roles taken by science teachers: sticker to facts, imposer, democracy advocator, and committed impartialist. The former two roles are based on monological discourse, whereas the latter two address dialogical discourse. In the first role (sticker to facts), teachers are not willing to explicate their own views and values. They believe that it is not science teachers' job to debate ethical and moral aspects (Levinson, 2001). Science and science education should be value-free (Sadler, Amirshokoohi, Kazempour, & Allspaw, 2006). Scientific knowledge is seen as the key, so the potential problems in teaching SSI can be avoided by sticking to facts (Oulton, Dillon, et al., 2004). Certain teachers in this group also feel concerned that they might try to advance a personal agenda if they make their positions explicit (Lee, Abd-EI-Khalick, & Choi, 2006). Aikenhead (2006) names this group as pipeline-enthusiasts. They possess an orientation engendering the transmission of scientific

knowledge and techniques in a canonical sense to persuade students of the correctness of a scientific worldview enhanced by positivism and realism.

A second group (imposer) prefers imposing their opinions and values about SSI on school students. Ratcliffe and Grace (2003) noted that teachers in this group preferred some strategies that supported their bias such as presenting their opinions as if they are facts, revealing their preferences by facial expressions and gestures, and highlighting a particular selection of facts and evidences fitting their opinions. Lemke (1990) hypothesizes that power relations in regular science classrooms may also be a dynamic at work here. Teachers are the ones who decide and/or mediate what is taught in traditional classrooms and the nature of power relations existing in classrooms may cause them to impose their views on students related to SSI as they do for scientific knowledge. Further, certain teachers in this group believe that there are common moral values in the broader community that should be honored. Therefore, they may make these values explicit even though they may not share some of them (Oulton, Dillon, et al., 2004).

Science teachers adopting a third role (democracy advocator) envisage a democratic discussion environment wherein all relevant perspectives are presented. The modest available research (Oulton, Dillon, et al., 2004, Oulton, Day, et al., 2004) suggests that most in-service and PSTs prefer this role. Data suggest that the reason for providing balanced experience is to allow students a range of opinions so they can make up their own mind and develop their own value systems. Playing devil's advocate to provide possible alternatives is a frequent proposed strategy (Dawson, 2011). Certain teachers in this group believe that they should provide equal coverage of sides in SSI discussions (Bryce & Gray, 2004) by providing equivalent quality and quantity of information for the various competing perspectives (Cross & Price, 1996).

Teachers in a fourth group (committed impartialists) also believe that they should provide different perspectives in a neutral manner; however, they believe it is very difficult not to make one's personal views and values evident. Therefore, they prefer explaining their positions but not imposing them on students; instead, they seek to be an exemplary role model, demonstrating to students how a responsible adult makes personal arguments and decisions (Kelly, 2002). Simonneaux (2007) found that many teachers who chose the third group's position preferred this role after a short time of in-service education about teaching SSI. Following the training, they considered that it was impossible to reduce SSI to mere scientific facts. They did not wish to train politically committed people. Rather, their desire to explain their views was to promote a cooperative approach in which teachers and students learn from each other.

Certain science educators (Oulton, Dillon, et al., 2004; Simonneaux, 2007) and citizenship educators (e.g. Kelly, 2002) advocate this fourth group's position. Oulton, Dillon, and Grace (2004) believe that sticking to the facts (group 1) is insufficient if students are to understand the controversial nature of SSI. They believe that the motivations, emotions, and beliefs that are important decision-making ingredients for people should be examined along with the relevant factual evidence. In addition, Oulton and others argue that teachers are aware that it is impossible to be unbiased in one's teaching. Teachers' course plans, choice of approaches, and resources frequently display bias even when teachers are attempting to be neutral. Cotton (2006), for example, noted that science teachers who espoused balanced beliefs experienced significant difficulties in enacting these beliefs in real classrooms. The approaches of the teachers implicitly turn to persuasion or indoctrination (group 2) rather than

democratic instruction. Oulton, Dillon, et al. (2004) argue that teachers should make their position explicit at the start of the exercise so that students are aware of potential bias in the way the teacher has arranged the experience and in what they say and do.

## Rationale for the Present Study

There are two starting points which stem from the gaps and the problems described in the literature above and on which we base the present study. First, the roles PSTs will take in SSI discourse constitute our research focus. When SSI are under consideration, it is important for science teachers to judge when, how, and if to express their own views and opinions (OXFAM, 2006). Previous research discussed above has showed that monological science teachers either prefer sticking to facts or explaining their position in order to for indoctrinate goals, whereas dialogical science teachers prefer providing a balanced perspective in SSI discourse. However, most of these arguments are based on research designs whose main aim is not to understand teacher's roles and their underlying reasonings for selecting those roles. In addition, the researchers did not have any goal such as comparing the teacher's roles and their underlying beliefs. Therefore, it is unclear what roles science teachers (preservice and in-service) do/will take during SSI discourse and what roles they should take. More importantly, it is unclear what driving factors (or beliefs) are influential in choosing these roles. This gap was one of the triggering factors for conducting the present study. Such research is crucial considering how much money, time, and energy will be spent for realizing current SSI-based reforms in Turkey and other countries. If teachers (preservice and in-service) embrace monological roles preferring indoctrination or sticking to facts, incorporation of SSI into the curricula may be highly problematic. Determination of the nature of beliefs about teachers' roles will thus provide vital information to help teacher educators prepare for, enhance, and predict possible success of SSI instruction in Turkey and in similar contexts.

Regarding our stance about supporting one of the roles, we argue that dialogical roles are preferable to monological ones in SSI discourse considering that scholars agree that monological discourses harm students' meaning and decision-making skills and that dialogical roles produce better epistemological understandings, argument skills, and disciplinary knowledge for students (Reznitskaya, 2012; Reznitskaya & Gregory, 2013). In addition, expected teacher attributes in SSI education such as collaboration and interaction, respect for students' ideas, being honest about knowledge limitations, and being willing to be a knowledge contributor rather than sole authority (Sadler, 2011) match well with dialogical roles. Regarding dialogical roles, apart from a few scholars such as Oulton, Dillon, et al. (2004) and Kelly (2002), there is no consensus as to whether teachers should disclose their position while creating a democratic environment. The works of Oulton et al. and Kelly are also based on theoretical assumptions rather than on definitive empirical works. Therefore, we could not endorse a stance between the dialogical roles of democracy advocators and committed impartialists because we do not yet have any reliable data showing that one role produces learning that is better than the other. However, we do not find such ambiguity problematic because we deal mainly with existing beliefs representing each role.

Second starting point is related to study context. We conducted the present study in a Turkish context. Turkey is one of the countries experiencing SSI-based education reforms. The Turkish Ministry of Education has recently updated the science curricula

(February 2013) by adding an emphasis on SSI. Development of scientific habits of mind using SSI is now one of the 12 basic goals of the science teaching program (Ministry of National Education, 2013). In 2012, before these developments, Kilinc and others (2012) conducted a few studies to understand in-service teachers' beliefs and practices regarding SSI. The researchers showed that Turkish science teachers usually presented SSI topics in underplanned learning environments because they did not possess the knowledge of how to address them (Kilinc et al., 2012). In the curriculum update of 2013, scholars prepared new science textbooks for grades 5 (science) and 9 (physics, chemistry, and biology) including certain SSI components. However, these curricular and textbook-based developments have not yet been reflected in preservice as well as in-service teacher education programs. It is unclear how current and future Turkish science teachers will engage in SSI. Therefore, we wanted to understand the beliefs of Turkish PSTs', who were in their final years of preparation, about the practical use of SSI in classrooms because they are about to be sent to real classrooms with a responsibility to cover these issues.

Bearing these two important starting points in mind, following research question has contextualized our inquiry: What is the nature of beliefs underlying PSTs' selection of teacher's roles during SSI discourse?

## Methods

With a constructivist epistemology and interpretivist research perspective, we used a qualitative research design in the present study. The purpose of this design is to collect qualitative data to determine belief themes unique to each teacher's role (Creswell, 2008).

### Sample

We selected Turkish PSTs as the sample in the present study using convenience sampling procedures. Eight Turkish universities with teaching science departments in different regions of Turkey were selected. The graduates of these departments teach science to the students in grades 6, 7, and 8. We reached 502 participants, but a total of 466 participants completed the written questionnaires (93 % response rate). Of these, 143 questionnaires were excluded due to insufficient data (no choice, lack of reason, limited writing, etc.). Therefore, 323 (97 [30 %] male, 226 [70 %] female) PSTs with a mean age of 21.6 (SD=1.55, range=19–39) constituted the sample. In addition, we purposefully selected year 3 and year 4 participants because these students had taken many pedagogical and science courses. In this sample, 270 (83.6 %) participants were in year 3, and 53 participants (16.4 %) were in year 4.

### Teacher Belief Questionnaire (TBQ)

TBQ included teacher's role vignettes. First, we investigated possible teachers' behaviors and practices representing four teacher roles (sticker to facts, imposer, democracy advocator, committed impartialist) in discourse of SSI in the existing literature. Because people develop different reasoning modes for different SSI topics (Topcu, Sadler, & Yilmaz-Tuzun, 2010), we secondly contextualized these roles in the discourse on

genetically modified (GM) foods by producing teaching vignettes. We selected this topic because of its popularity in the Turkish media and because it is widely studied by SSI researchers. After that, we put these vignettes into a questionnaire form. We asked PSTs to choose one of the roles that they preferred among the four and to evaluate their selected roles by writing reasons for why they choose them as preferable. We used these compositions for further content analysis.

After the development of the TBQ, a meeting was held with 16 participants for the purpose of refining this subquestionnaire. This group included four science education professors, a professor who worked in genetics and biotechnology, a professor who was an expert in statistics and the development of questionnaires, a reading education professor, a lecturer from the Turkish Language and Literature department, three doctoral students, and six masters students. This group scrutinized the vignettes and the layout of the subquestionnaire in terms of content and language. Minor changes were made to certain sentences. The final version of TBQ is displayed as Supplemental Material.

All of the lecturers at the universities in the sample distributed the questionnaires in their regular classrooms and allowed time for the clarification of participants' queries. The participants completed the questionnaires in approximately 25 min.

### Data Analysis

We entered written questionnaires to Excel and printed them out. All transcripts were analyzed independently by two researchers. The researchers performed content analysis procedures suggested by Creswell (2008). All transcripts were read two times. In the first stage, small belief themes (reason categories) representing each role were determined, and they were put together under main themes or belief patterns. For example, we collected small belief themes such as "I should protect children" and "GM foods are harmful, so I should inform the students' under the main theme of 'protecting children from harmful foods." In the second stage, we brought together the main themes across the teacher's roles. In the third stage, to reach a final decision about the themes included in each role, we calculated the inter-rater reliability coefficients following first two coding processes. First, two researchers worked together to discuss the principal themes that they had identified. Upon achieving consistency in terms of the main themes, they examined the number of participants that they had jointly nominated to each belief theme. Inter-rater reliability coefficients were used to represent the percentages describing the overlap between two researchers' classifications of the participants. Considering that there were four vignettes to be selected, we calculated four inter-rater reliability scores. These scores ranged between 0.72 and 0.90. In addition, these researchers came together in one another meeting in order to reach 100 % agreement about the classifications. In the final stage, the sample excerpts representing each theme were ascertained.

## Results

In this section, we describe our qualitative findings that we produced by analyzing PST's compositions about selection of each of the four teacher's roles.

### Stickers to Facts

Twenty-seven (8.4 %) participants selected this role. As shown in Table 2, we found four major reason categories. All these categories consist of value perspectives. Out of 27, 14 (51.8 %) participants adopted positivistic epistemologies and suggested that science and its teaching should not include values. Another group believed either that teachers' values can affect students' opinions ($N$=3, 11.1 %) or that students' sociocultural backgrounds can conflict with teachers' values ($N$=6, 22.2 %). Both of these themes led participants to develop anxieties about their future instruction. Four participants (14.8 %) accepted that science was a value-based issue but stated that it was not their job to incorporate these values in their programs; rather that responsibility belonged to other teaching departments such as religious education and social studies education.

### Imposers

Twenty-four participants (7.4 %) selected this role. As shown in Table 3, three somewhat overlapping reason categories emerged from the data. Regarding the first, 16 participants (66.6 %) definitively believed both that GM foods were harmful to one's health and that it was their responsibility to clearly communicate this adverse health impact to students. Not doing so in direct and convincing ways would constitute negligence on their part. Another related group including five participants (20.8 %) suggested that students needed to reach certain truths about this crucial subject and not be distracted or paralyzed by confusing opinions and data. Members of this group believed teachers should guide students to understand these certain truths. Complementing epistemological and ethical perspectives, a third set of participants ($N$=3, 12.5 %) appeared to focus on pedagogical imperatives, believing that teachers' legitimacy and credibility rested on their assuming an authoritarian role in classrooms, one which demanded that they demonstrate their superior knowledge about the realities and implications of the subject matter. Too much highlighting of uncertainties was apparently presumed to undermine this authoritative role.

**Table 2** The reason categories about choosing stickers to facts

| Reasons | $N$ | % | Sample excerpts |
|---|---|---|---|
| Seeing legitimate science as value-free | 14 | 51.8 | The truth of scientific knowledge increases as it moves away from values and beliefs. |
| Showing proper cultural sensitivity | 6 | 22.2 | Society is made up of different sociocultural components. The schools are mirrors of this structure. Therefore, the discussions can continue in wrong directions. |
| Maintaining focus on science not values | 4 | 14.8 | We should look at the issue more scientifically. This is our job. Religion, morality, and social issues are not included in my subject matter area. |
| Minimizing the undue influence of teachers' values on students | 3 | 11.1 | The subjects that teachers will teach should not include their comments. The issues involving comments may affect students. Therefore, teachers should only share scientifically proven information. |

**Table 3** The reason categories about choosing imposers

| Reasons | *N* | % | Sample excerpts |
|---|---|---|---|
| Protecting children from harmful foods | 16 | 66.6 | I want nobody to be harmed because I know GM foods are harmful. Therefore, I try to instill my ideas to students. |
| Reaching absolute truths | 5 | 20.8 | Senseless opinions about GM foods should be prevented. |
| Embodying the proper authoritative role of teachers | 3 | 12.5 | Because my knowledge is always more correct than students, I try to completely inform them. |

## Democracy Advocators

One hundred eighty-eight (58.2 %) participants selected this role. As shown in Table 4, six reason categories were identified. About a half of these participants (*N*=82, 43.6 %) believed that students would better learn the conceptions and different views about GM foods via discussions that impartially examined multiple perspectives on issues as opposed to more traditional learning techniques based on concept memorizing. At their impartial best, during discussions, students explore and analyze multiple sources of information, formulate and prioritize positions, and uncover and reevaluate misconceptions. Overall, students learn how to defensibly support and critique their own and others' knowledge claims and value propositions based on logic, scientific evidence,

**Table 4** The reason categories about choosing democracy advocators

| Reasons | *N* | % | Sample excerpts |
|---|---|---|---|
| Achieving a better learning environment | 82 | 43.6 | They will analyze data and grasp positive and negative aspects. Therefore, learning would be more permanent. |
| Promoting broad skill development | 43 | 22.9 | I do not want to impose my ideas on someone. I make students think pluralistically instead of narrow understandings. They will be open for any critique in the future. |
| Embracing a "guide" role in discussing SSI | 25 | 13.3 | Teachers are a guide here. There is a democratic environment. There should be no pressure on students and students' opinions are valuable. |
| Minimizing the distracting effect of teacher self-disclosure | 14 | 7.4 | Teachers are a model for students in the classroom environment. Students would not think as to whether the ideas of teachers are wrong or correct if the teacher tells his/her ideas. Teachers should lead discussions without explaining their position. |
| Enhancing more autonomous student decision-making | 14 | 7.4 | I get students to express their own ideas explicitly. They then make decisions on their own. |
| Understanding what students think and know | 10 | 5.3 | All of the students should make their opinions explicit and how much they are aware of GM foods should be seen. The wrong knowledge should be corrected accordingly. |

and bias analysis. In so doing, learning becomes less egocentric and superficial, more collaborative, and well-considered, both more solid and more fluid.

Besides the skill development implied immediately above, 43 participants (22.9 %) emphasized other desirable capacities that students would develop via impartially grounded discussions. These include enhancing general communication skills, thinking critically and pluralistically, cultivating respect for opposite stances, gaining empathy, and strengthening self-regulation of one's own learning.

Moving from the benefits of impartiality to a focus on neutrality, 25 participants (13.3 %) suggested that teachers should adopt a "guide" role during discussions. Teachers should not impose their opinions; rather, they should direct discussions as moderators. Teachers should create an independent and democratic environment where students can express themselves easily and safely, enhancing their self-confidence in the process. As another set of participants noted ($N$=14, 7.4 %), this type of freely expressive environment is best cultivated when students do not have to worry about pleasing or contradicting what a respected teacher might view as the preferred position on a SSI. Affirming the goal of student critical autonomy even more explicitly, another group including 14 participants (7.4 %) believe that teacher neutrality has a liberating effect on students' developing their own viewpoints, whereas teacher self-disclosure can depress or distract students' creative independence of thought. Finally, in the liberating context of teacher neutrality, ten participants (5.3 %) focused on the diagnostic and pedagogic benefits that discussions afford in terms of eliciting students' preconceptions and personal opinions on the subject matter. With this knowledge, teachers are in an advantageous position to correct misconceptions and biases and, more broadly, to determine teaching strategies according to students' existing cognitive and evaluative frameworks.

### Committed Impartialists

Eighty-four participants (26 %) selected this role. As shown in Table 5, seven reason categories were found. With an emphasis on the impartiality dimension, about a quarter ($N$=22, 26.2 %) suggested that, amid controversy, truth is best attained through an objective, teacher-aided process of discussing and critiquing relevant, multiple perspectives. According to 20 participants (23.8 %), this process served to raise students' awareness of important issues and permitted the airing and, as needed, adjusting of their perspectives and misconceptions. Sixteen participants (19 %) cited reasons for teachers taking on a committed, i.e. self-disclosing, role in SSI discourse. They believed that students would gain analytic and deliberative thinking skills when teachers modeled how they reached their own conclusions on controversial issues. Additionally, participants emphasized that teacher self-disclosure could be exemplary in other concrete and expansive ways: as a model of expressing responsible concern about the harm of certain GM foods ($N$=14, 16.7 %); as a catalyst for students expressing their own passionate beliefs about issues ($N$=8, 9.5 %) and for their cultivating themselves as persons of character; and, more generally, as an inspiration for students to become more conscious, informed, and active citizens ($N$=2, 2.4 %). Highlighting the classroom as a propitious site for nurturing citizenship voice, another group including two participants (2.4 %) explicitly emphasized that teachers are also a part of the classroom environment and should be encouraged to express themselves in order to create a robust democratic

**Table 5** The reason categories about choosing committed impartialists

| Reasons | *N* | % | Sample excerpts |
|---|---|---|---|
| Reaching important truths through a fair-minded, objective process | 22 | 26.2 | Truth is single. The knowledge that students need to know should be given objectively. |
| Raising awareness about GM foods | 20 | 23.8 | I want to correct misconceptions of students. I raise awareness about these issues. |
| Modeling thinking skills | 16 | 19.0 | It is necessary to be a model about the processes of thinking that are related to informed decision-making. |
| Protecting children from harmful foods | 14 | 16.7 | I think GM foods harm humans. I inform my classes in this direction. Also, I try to know students' opinions. |
| Encouraging students' expressiveness | 8 | 9.5 | There will be a discussion environment where students are encouraged to express their ideas since I tell my ideas. |
| Cultivating character development | 2 | 2.4 | The teacher really adopts the teaching profession in this stance. They help students to develop new ideas and enable them to reach the truths by means of proofs. Therefore, they create a generation who can think, find the truths, are open-minded, and have national values. |
| Creating a democratic environment | 2 | 2.4 | Putting forward my opinion does not mean that they should adopt it. It would be useful to vaccinate the philosophy of "every person can have different opinions." |

environment where everybody, teacher and students, can respectfully exchange their often diverse and unique ideas.

## Discussion and Implications

In the present study, we tried to understand the nature of the beliefs of PSTs about teacher's roles in SSI discourse. First, considering descriptive results, it is encouraging that only a small percent of PSTs chose monological roles (8.4 % sticker to facts, 7.4 % imposers). Even though this result might be explained by social desirability reasons, we clearly see that most PSTs have a tendency to select dialogical roles. This result indicates that current Turkish PSTs appear to prefer democratic environments wherein all stakeholders' perspectives are discussed in their future classrooms. This result is promising. If PST role preference is realized in practice, current SSI-based reforms in Turkey may experience successful days in the near future. However, further investigations regarding the beliefs backing each role are necessary because these descriptive results in themselves cannot display important alignments between desired beliefs, teacher's roles, and actual teacher practice.

With regard to the role of stickers to facts, we saw that more than a half of the PSTs chosen this role possessed absolutist epistemologies in the transcripts such as the belief that science is based only on facts rather than values and ideologies and the belief that teachers (knowledge authorities) should transmit knowledge without comments.

Considering that people use their personal epistemologies in conceptually understanding the topics (e.g. Hofer & Pintrich, 2004), PSTs with such absolutist epistemologies might stop processing the understanding of these controversial issues and select specific components such as facts and evidences rather than beliefs and conflicts. Recent research may also support this line of reasoning: Baltaci and Kilinc (2014) found that PSTs who considered that knowledge was certain and was made up of isolated facts developed low level teaching efficacy beliefs about the organization of SSI argumentation environments. Perhaps epistemological background is an important component in teaching these epistemologically sensitive topics. This result is also in line with previous research findings regarding this teacher's role (Levinson, 2001; Sadler et al., 2006). In addition, previous experiences in PSTs' education may be one reason for PSTs' problematic epistemological reasoning. A few participants said that science might include values, but it was not their job to teach this side of science while there were other teaching departments such as social studies education and religious education. Perhaps these curricular organizations and distributions produce certain prejudices such as the fact that teaching science should only include laboratory activities and memorization of scientific formula and facts. One another group including six participants believed that science was not value-free, but they had concerns about sociocultural nature of these topics. This concern was also observed in the study of McGinnis and Simmons (1999). Perhaps the lack of experience and of pedagogical background on how to manage the cultural sensitivities without causing unintended conflicts and debates among the students is one another barrier before dialogical SSI discourse.

PSTs with similar absolutist epistemologies and certain problematic teaching goals (e.g. protecting children from harmful foods) selected imposer role. Perhaps implicit interrelationships among these components produce similar beliefs for imposers. Perhaps a core belief cluster rooted in absolutist epistemologies is related to moral responsibilities of the teachers. In other words, perhaps PSTs have right absolute truths (e.g. genetic modification is harmful to human's health) in their minds, and these truths are readily associated with right accepted moral goals of teaching such as protecting children from harmful foods. This core cluster may also work as a barrier in processing knowledge related to learning alternative viewpoints about controversial topics. Consistent with this core cluster, a third set of participants appeared to focus on pedagogical imperatives, believing that teachers' legitimacy and credibility rested on their assuming an authoritarian role in classrooms. This reasoning is consistent with Lemke's (1990) arguments regarding power relationships in the classrooms.

More than a half of the PSTs (58.2 %) preferred the role of democracy advocators. Even though this result seems encouraging, a reason category that PSTs suggested leads us to reconsider such a positive result. Ten PSTs said that one of the goals of organizing such dialogical discourse should be to correct what students think and know. Similar findings were also found in Pimentel and McNeill's (2010) works. This shows that some PSTs confuse the paradigms of recitation and discussion (Reznitskaya, 2012). They appeared, at least implicitly, not to be vitally aware that SSI fundamentally includes arguments with different degrees of certainty and correctness. Considering this reason category, a small portion of democracy advocators, in practice, may take on the role of an imposer. This estimation is also consistent with existing science education literature (Cotton, 2006). Other than this reason category, we appreciate the better

learning opportunities, intellectual goals, and guiding role of teachers that were emphasized by most of PSTs preferring this role. Considering such components of dialogical discourse are related to constructivist ideologies that are heuristically and practically emphasized in Turkish science teacher education (Ministry of National Education, 2013), perhaps many PSTs readily made connections between democracy advocator role and pedagogical benefits of student-centered constructivist environments. With regard to concern about teacher's excessive influence perhaps these PSTs ($N$=14) believe that if students do not know where the teacher stands, they will be forced to rely more on their own critical intelligence. While we applaud the goal of fostering students' critical intelligence, a few scholars such as Oulton, Dillon, et al. (2004) consider that depriving students the opportunity to compare their own perspectives and skills with those of a respected adult could undermine not protect or promote their critical intelligence. However, because these arguments are based on theoretical discussions rather than strong empirical evidences, we are inclined to reserve judgment about unconditionally endorsing the role of committed impartialist over that of democracy advocator.

About a quarter (26 %) selected another dialogical role: committed impartialist. With important distinctions, the beliefs of committed impartialists contain similarities to the roles of imposer and democracy advocator. Akin to imposers, committed impartialists are open to reaching tenable truths on SSI by correcting students' knowledge, and they value protecting children from harmful foods. Like democracy advocators and in contrast to imposers, they tend to be aware of different alternatives and scientific claims. Perhaps certain PSTs with absolutist epistemologies either select indoctrinating their opinions (imposer) or choose a softer version (committed impartialist) of it. In both cases, they are willing to take the students through their "important" truths (Mansour, 2010). Furthermore, committed impartialists share most of the intellectual goals of democracy advocators. However, there is a sharp distinction about reaching such goals. Democracy advocators believe that teachers' disclose of personal opinions should be prevented in order that students find opportunities to enhance their intellectual capabilities. In the case of committed impartialists, teachers' disclose is accepted as a prior condition to model thinking skills, to encourage students' expressiveness, and to create a democratic environment where teachers are also a part of classroom community. In addition, we found another intriguing result about moral teaching goals. Two committed impartialists believed that teachers may work as a catalyst for cultivating students as persons of character and, more generally, as an inspiration for students to become more conscious, informed, and active citizens. Considering scholars and teachers strive to enable strong character development by using SSI contexts these days (e.g. Lee, Chang, Choi, Kim, & Zeidler, 2012), finding such a reason category in the depths of only a few PSTs' belief systems showed the lack of emphasize on these global goals of science education in Turkish context.

Overall, consistent with existing discourse literature (e.g. Reznitskaya, 2012), a combination of epistemologies and teaching goals appears responsible for PSTs' selection of the preferred teacher role in addressing SSI re: GM foods. In particular, a combination of absolutist epistemologies and problematic teaching goals (e.g. protecting children from harmful foods by imposing personal opinions) were important parameters in selecting monological roles. Even though most PSTs selected dialogical roles, partially distinct from existing literature, they also displayed absolutist

epistemologies and similar problematic teaching goals (e.g. raising awareness about GM foods by correcting students' opinions). These results are not very good signals for the future of SSI-based reforms in Turkish context. Even though Turkish curriculum makers try to catch up the "trend train" turning around the world by embedding SSI into existing curricula, the beliefs of PSTs, or of next year's fresh teachers', whisper a different story. Based on previous research findings and the present results, it is clear that evaluatist epistemologies supported by existing intellectual goals and prominent moral goals such as promoting character development and raising scientifically responsible generations will be optimum for reaching science teachers who choose dialogical teacher's roles in SSI discourses. Well-conceived teacher education programs better grounded in a critical understanding of the various roles and practices that support and undermine teachers' capacities to confront SSI in Turkey and other contexts would appear to be a vital force in achieving such a compelling goal.

Bearing these findings and perspectives in mind, we suggest following three practical implications based on our empirical results:

Implication 1: We found that there were four different combinations of beliefs embodied in the teacher's roles represented in the present study. These combinations included different ingredients that are related to epistemologies and teaching goals. Considering that these ingredients build variations in each teacher's role, any intervention to make these beliefs better should take into account this diversity of beliefs. Therefore, teacher educators who are willing to invite monological preservice and in-service teachers to consider and embrace more dialogical discourse versions need to understand teachers' existing diverse beliefs and make them explicit. This awareness may help teacher educators produce successful interventions that are specifically designed for each role.

Implication 2: Based on our results, below in Table 6, we suggest enhancement opportunities for epistemological beliefs in each role. Science teacher education programs and curricular documents in pedagogy courses could benefit from the enhancement opportunities on the list in Table 6. Considering that the absolutist epistemologies were one of the strong reasons for teacher's role selection, these

**Table 6** Enhancement opportunities for epistemological beliefs

| Roles | PSTs' existing beliefs | Beliefs for dialogical discourse |
|---|---|---|
| Sticker to facts | Seeing science as value-free | Seeing science as value-loaded |
| | Maintaining focus on science not values | Affirming value-loaded science teaching |
| Imposer | Reaching absolute truths | Reaching best arguments |
| | Embracing the authoritative role of teachers | Embracing the collegial role of teacher |
| Democracy advocator | Understanding what students think and know | Hearing different voices without a sharp correction goal |
| Committed impartialist | Reaching important truths through a fair-minded, objective process | Reaching important truths and best arguments through a fair-minded, objective process |

opportunities show that there is an urgent need to reorganize science teaching programs based on epistemologically oriented frameworks. On this point, the curriculum makers can benefit from a range of successful explicit nature of science (NOS) and epistemology courses described in the existing literature (e.g. explicit NOS instruction activities (Akerson, Abd-El Khalick, & Lederman, 2000); teaching ethics (Reiss, 1999); productive disciplinary engagement (Engle & Conant, 2002); discussion of ill-structured problems (King & Kitchener, 1994); use of autobiography (Bushnell & Henry, 2003); group discourse and journal writing (Hill, 2000); use of images of scientists' activities (Hofer, 2001)).

Implication 3: Complementing implication 2, we noticed teaching goals were another core pedagogical belief in the selection of teacher's roles perhaps they are very influential in the selection, timing, and implementation of learning activities in SSI education (Dawson, 2001). Compared to epistemologies that are developed through a long-term schooling process (Hofer & Pintrich, 2004), the teaching goals can be more readily determined by the particular expectations of specific SSI reforms. As we discussed above, two moral teaching goals suggested by PSTs who selected dialogical roles seem problematic: protecting children from harmful foods and raising awareness about current issues. To enhance the achievement of these goals in a non-dogmatic fashion, science teacher educators can first create opportunities so that PSTs make their desired roles explicit. Additionally, teacher educators can produce an argumentation environment where they or PSTs make desired SSI goals explicit. For example, in such an environment based on cognitive dissonance (Pajares, 1992), following discussion between an imposer PST and a science teacher educator can be envisaged:

*Imposer PST:* I know that GM foods are very dangerous so I should explicitly explain its negative impacts in order to protect children from these harmful foods.
*Science Teacher Educator:* I appreciate your sensitivity to children's health. Yes, GM foods can be harmful to children and these harmful effects can be well-documented by research. However, due to its science-in-the-making nature, improvements in the development of GM foods have been and continue to be made. How might you help your students thoughtfully weigh the important and potential benefits from such production against the discernible and plausible costs?

We would argue that other moral teaching goals such as cultivating character development and creating a democratic environment as well as the intellectual teaching goals articulated by PSTs, such as promoting thinking skills' development, encouraging students' expressiveness, and enhancing more autonomous decision-making, can directly be used by science teacher educators in order to make dialogical roles attractive to PSTs. Science teacher educators can find a range of practical implications on how to reach such moral and intellectual goals in pedagogical sense in existing literature (moral development: Lee et al., 2012, creating a democratic environment: Rainer & Guyton, 1999, global citizenship activities and coping with cultural concerns: OXFAM, 2006; reaching intellectual goals: Ritchhart & Perkins, 2004).

## Limitations and Future Perspectives

As is characteristic of all scientific work, the present research also includes certain limitations. Even though the four roles we embedded in our questionnaires were frequently mentioned in the SSI literature, we wonder whether there may be other important roles that science teachers may enact in their teaching. We believe that follow-up interviews and real classroom observations will inform our perspectives and may produce the identification of additional teacher's roles in addressing SSI. In addition, we are aware that certain teachers may change their desired roles when teaching controversial issues. Due to the "cold" nature of the questionnaires, we could not see such change that is possible in "hot" classroom environments. A study which can better capture these adaptations would be intriguing.

We classified the roles of sticker to facts and imposer under monological discourse and the roles of democracy advocator and committed impartialist under dialogical discourse. Existing literature in different educational disciplines support and promote dialogical environments. However, we could not legitimately prescribe a preference between democracy advocator and committed impartialist because we do not yet have any reliable data showing one roles' learning products are better than the other. Experimental designs comparing student learning outcomes under these two teacher roles should enhance our capacity to make more informed judgments on this matter.

Finally, even though certain belief themes such as showing cultural sensitivity and reaching absolute truths pointed out certain cultural points that were unique to Turkish context, because the participants using these themes had short written responses, we could not have opportunity to deeply examine the cultural factors. Considering culture is one of the important dimensions in the development of epistemologies (Hofer, 2001) and teaching goals (McGinnis & Simmons, 1999), perhaps a more culturally oriented research (e.g. ethnomethodology) may uncover the relationships between the belief structures and cultural components (e.g. values, world views, etc.).

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