Interest, Instructional Strategies, and the Creation of Group Space.

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Abstract: *Research on small-group work and on whole class discussions has shown specific benefits for student learning. At the same time, research on interest stresses the generation of situational interest when particular learning conditions are met. This qualitative study explores whether the type of instructional strategy (small group vs. whole class discussion) influences triggering of situational interest about theoretical and practice-oriented pedagogical topics among preservice science teachers (N = 44). Triggering of interest was identified by participation rate, degree of comfort during interactions, and quality of arguments. Results show that whole class discussions of theoretical topics shifted towards practical teaching issues, while small groups sustained the theoretical nature of a topic. Both interaction patterns imply triggering of situational interest. But the small group interaction patterns indicate the collective construction of a "triple problem-solving space", in which content, social/relational, and interest were balanced from the start; the whole class discussions needed first to renegotiate the content.*

Keywords: *Situational interest, small group learning, whole class discussion*

I. THEORETICAL FRAMEWORK

TThere is consensus in the research literature that interest is content-specific [1], describes a person's focused attention, and that certain features of a learning situation (e.g., working in small groups) or specific tasks may trigger a person's interest regardless of their personal preferences regarding the situation [2].Hidi and Renninger [3] identified four phases in the development of interest: triggered situational, maintained situational, emerging individual, and well-developed individual interest. This study focuses on the earlier phases of interest. Triggered situational interest can be sparked by a feature of a text, a task such as surprising information or contradictory statements, a personal relevance or identification [4], or generated by an instructional setting (e.g., group work); and it may or may not result in further engagement with the text or task. Maintained situational interest is seen as emerging from triggered situational interest and may include focused attention and perseverance at a task over a longer period of time.

Small group work and whole class discussions are major instructional strategies in most learning contexts. Are there differences in how they trigger situational interest about certain science teaching topics?

Proponents of small group work claim that collaboration within a group leads to shared goals and values; develops collective and individual responsibility; and stronger engagement, interest and motivation [5]. Well-structured and managed group work allows students to develop communication skills by defending their work based on evidence, to learn from other groups, and to engage in problem solving that mirrors future work and life experiences. However, other research has demonstrated that students often avoid small group work because of task-related conflicts [6] or tend to agree with or acquiesce to other group members [7].

Whole class discussions allow for student-teacher and student-student interactions, with teacher questioning as the most obvious feature [8].Teacher questioning in whole class discussions has been found to elicit student thinking when the questions refer to students' experiences; diagnose and refine student ideas; and help students to clarify, explore and monitor their thinking and points of view [9]. Similarly, Roth [10] showed how teacher's questioning "drew out" student knowledge and lead to student-centered discussions.

Based on research about small group work, whole class discussions and interest, this study asked: Does the type of instructional strategy influence triggering of situational interest? If so, how?

II. METHODS

This qualitative study was conducted over the duration of one semester with a group of preservice science teachers (PSTs) (N = 44) who were enrolled in a one-year post-baccalaureate teacher preparation program at a public university. All PSTs had a B.S. in one of the science disciplines and approximately 15% also a M.S. in a science sub-discipline. During the one-year teacher preparation program that was comprised of year-long required and elective courses all PSTs taught twice for five weeks in middle or high schools in their teaching subjects and had to complete a four-week educational internship.

Context

Data were collected in an elective course addressing theoretical and practical issues of teaching and learning science through inquiry and in a required science methods course focusing on teaching and learning science in middle and high school. The overarching goals of both courses were to develop(i) awareness of, interest in, and enjoyment of the diversity of science; and(ii) knowledge and skills to teach

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inquiry-based science toprovide opportunities for students to conduct and critique science and technology in our society. Grounded in constructivist learning theories, the courses stressed that conducting one's own scientific investigations and invention projects in small groups lead to more independent, critical, and creative thinkers.

Each in-class activity in both courses focused on a pedagogical topic and followed a specific design: Small group work followed by whole class discussions. Topics were all grounded in theory that had practical applications. Most started from the theoretical level through a hands-on activity and concluded with practical, teaching and learning specific discussions. For the purpose of this paper we focus on two examples reflecting the spectrum of topics in both classes: The first topic addressed the Nature of Science stressing questions such as: what is science, what is the purpose of science, and who does science? as well as the question: what shall be taught to middle and high school students about the Nature of Science? Students were asked to first, draw a scientist at work, then in small groups of four to five, describe and discuss their pictures, followed by a whole class discussion analyzing their drawings based on the above questions about the Nature of Science. The second topic focused on the purpose and structure of scientific investigations. PSTs in small groups were first, engaged in a guided inquiry investigation that asked: "Why does a helicopter fly?" PSTs then had to arrange words reflecting steps during such guided inquiry investigations in order to develop a procedure for scientific investigations on which all group members can agree upon (see Table 2). During the whole class discussion PSTs presented and provided a rational for their arrangements. Questions such as purpose of scientific investigations in general and different types of scientific investigations (teacher demonstrations vs. student inquiry lab) arouse during the whole class discussion were probed by instructor questions stressing issues of different learning styles and theories. For all these activities PSTs were given clear instructions of what to do followed by open-ended questions that illicit their prior knowledge and demanded integration of new knowledge based on peers' and instructor's feedback during small group and whole class discussion. With respect to the Nature of Science topic PSTs reflected on their own stereotypes of scientists as well as their perceptions about the Nature of Science. The activity emphasizing the purpose and structure of scientific investigations also solicited PSTs' prior knowledge about steps of scientific investigations and comparing and maybe revising their knowledge and perceptions based on peers' understanding in order to developed a group accepted arrangement of steps. Other topics addressed in small group and whole class discussions included: purpose and types of assessment for inquiry lessons, which also discussed the question whether assessment can be objective; function of schools in society and how these functions influence the teaching of science; or status of everyday conceptions in relation to scientific concepts.

Data collection and analysis

Whole class discussions and small group interactions were videotaped. For the analysis videotapes were first divided into individual clips. A clip reflects a unit of an interaction in small groups or whole class discussions between PSTs or PSTs and the instructor in which a statement is presented oran opinion expressed with or without supporting evidence, a response is given which build or doesn't build on another person's point or argument, an example or personal experience is provided to either support one's own opinion or that of another person, evidence to back up a claim is used, or a developed opinion and support for this opinion is expressed[11].These clips were fully transcribed, and then analyzed by two raters independently identifying on- and off-tasks interactions, number of PSTs interacting, and quality of interaction (e.g., providing evidence for claims).

A second round of analysis then focused on additional indicators of triggering of interest such as curiosity questions, arguments that indicated that the PST wanted to know more about the previous statement or asked for more information, or whether the argument indicated a personal utility value [12]. These analyses were conducted for each instructional strategy followed by a comparison across both instructional strategies (see Table 1).Two raters independently analyzed the clips followed by a comparison of their results. Inter-rater reliability was about 87 percent. Differences between raters' results were discussed until agreement was achieved.

III. RESULTS AND DISCUSSION

Results revealed some surprising relationships between instructional strategies and the nature of the topic. In general, whole class discussions initiated by a theoretical question shifted quickly towards PSTs' interactions about practical issues (e.g., concrete teaching episode), while PSTs discussions of such questions in small groups showed a longer engagement of theoretical-based topics as long as at least one group member provided connections between theory and practice. In the following we will describe and discuss a representative example of each of these interactions. Table 1 and Table 2 show an exemplary clip and its analysis of a whole class discussion and of a small group interaction.

Whole Class Discussion

During the whole class discussion on the topic Nature of Science, the instructor posed challenges to PSTs' beliefs about "truth" in science after students argued with axiomatic scientific knowledge. Only one PST responded with a theoretical comment (Louise, see Table 1) before another PST(Nancy) shifted the discussion to a concrete, practical level by decrying the challenge of providing students with practical experiences of doing real science. Another PST picked up on this theme and shared personal experiences from student teaching (see Table 1), which was followed by other PSTs' experiences. The argumentation intended by the original question was lost. The nature of the topic switched from theoretical to practical, and it seems that the instructor complied with PSTs' direction of the discussion by "giving up"; she did not try to get the discussion back to the theoretical level. In a way, PSTs resisted the instructor's efforts to engage them in a theoretical discussion by changing the nature of the topic, which the instructor accepted without further efforts to reintegrate; she moved on to the next topic.

McFarland [13] describes resistance as social drama. In this sense, the PSTs' engagement can be described as "resistance" and "closed negotiation" (p.1293). The instructor's move was either based on her lack of effective strategies for guided inquiry or on an assessment of PST's learning which necessitated "displacement" [14] of the original topic with a new topic. A closer look at the clip in Table 1 shows, that the instructor had asked two questions at the same time. The second question referring to the first question asked, "What shall we teach our students about it?" and "it" referring here to "truth" in science in the first question. Although it might not be the instructor's intention, the second question allowed PSTs to engage in a discussion on concrete practical teaching issues and thus avoiding a demanding theoretical discussion. The latter may also not be of interest to them. All PSTs had been just back from their first four-weeks of student teaching. They were eager to discuss what they had learned, what issues they had to tackle, and how they would address these in order to be prepared for their next student teaching. Their minds were set on practical support; theoretical topics seemed of lower priority. PSTs' enthusiasm to engage in practice-based discussion may indicate a maintained situational interest[15]. PSTs participated in higher numbers, showed a much greater degree of comfort when expressing their opinions about the concrete and practical, and their arguments were stronger (with respect to providing evidence for claims) than responses to theoretical questions. The latter were weak and only occasionally included supporting evidence (see Table 1).

Table 1: Example of a Clip and its Analysis during Whole Class Discussion on the Nature of Science.

	Quote	Nature of topic/interaction	Interaction type/argumentation pattern	Comments
Instructor	"...What is 'truth' in science? ... What shall we teach our students about it?"	Theoretical	Two question to whole class	
Louise	"We need to give students a broad view of science; .... I only present my own experience and give students a biased perspective... as teachers we need to try to find out what other scientists do."	Theoretical	Response to instructor's question; stating argument with some evidence	
Nancy	"It's hard to bring 9th graders outside to show them what other scientist do."	Practical	Counter argument without evidence	No relation to Louis's statement; switching nature of interaction from theoretical to practical constrain
Sam	"It's possible, I have done it."	Practical	Referring to previous statement; providing some evidence	No reference to original question or Louise's statement

Small Group Discussion

Results of small group work showed different patterns than the whole class discussions. As long as at least one group member provided connections between theory and practice, PSTs discussions centered on theoretical topics and examples from their teaching practice or from class activities were used to illustrate or support their arguments. During the topic on the purpose and structure of scientific investigations PSTs in groups of 4 to 5 were asked to arrange words reflecting steps during scientific investigations (e.g., asking questions, observations, experiment, data, conclusions, evidence, etc.) in a way that shows the group's views of scientific investigations. The purpose of this activity was to demonstrate variability in scientific procedures and to challenge the common misconception that scientific investigations follow predetermined steps (the so called "scientific method"). In one group, a member referred to an inquiry activity that they did in class ("…We just dropped the paper helicopter…") in order to discuss whether observations come before asking questions or whether there is first a question. The PST uses a concrete example is used to support her argument.

During another small group's interaction of the same activity on the purpose and structure of scientific investigations group members discuss whether a theory develops into a law or not in order to decide which of these steps comes first. This interaction is shown in Table 2. All group members' arguments, counter arguments, or questions stay on the theoretical level and a concrete example is used to support the argument. Similar results were found in the other small groups; the discussions stayed on the theoretical level.

These small group interactions reveal PSTs' interest in the activity. All group members attended to the task and content at hand, asked questions to each other, and used evidence to support their claims, which are learner characteristics indicating triggering of interest [16]. In contrast to the whole class discussion, the instructional arrangement of small groups provided for our participants a psychologically safe space to articulate one's thoughts as the exchange between Anna and Patricia show:

Anna: You know what. We could maybe put observations up here because you wouldn't really be doing qualitative…because observations are more qualitative and then collection of data is more quantitative.

Patricia: But I think observations are actually coming during the experiment, like you're collecting…like we were collecting the time that the helicopter fell but we were also when were we looking at the wing design we were observing whether you bent it this way of that it would fall…

The small groups also allowed PSTs to grapple with the content and to admit that one lacks knowledge; the interaction between Maria, Emily, and Aziz is an example of such an interaction:

Maria: What's the difference between deduction and inductive?

Emily: What's the difference between deducting and inferring? (pause) Okay wait. So Sherlock Holmes deduced things so he had the clues…

Aziz: Ya, the clues

Emily: …so it was after the fact.

Aziz: So inductive is…

Maria: So what is inductive.

Emily: Before!

Maria: If deductive is after, inductive…

Aziz: Inductive is based on general knowledge of something.

Emily: ummm…I have no idea what inductive reasoning is.

Maria: No clue.

Table 2: Example of a Clip and its Analysis during Small Group Discussion on Arranging Steps of Scientific Investigations.

	Quote	Nature of topic / interaction	Interaction type / argumentation pattern	Comments
Patricia:	Or…except we didn't really go about that. We went about the wing design but gravity comes into it so it's one of the theories that you would present at the beginning as part of your knowledge.	Practical and Theoretical	Proposing counter argument; connecting to activity	
Meagan:	Part of what I said in the first one was our theory was the more weight you put on it, that was our hypothesis. When is the hypothesis different than the law? When does a theory become a law? How many times do you have to prove it? Do you have to go about it all the time? When does a hypothesis become a theory?	Theoretical	Proposes argument with evidence; Poses questions to group	Poses exploratory questions to the group that are theoretical in nature
Anna:	In theory what sense of the word?	Theoretical	Poses question/seeks clarification	
Patricia:	In that case you could put theory and law at the beginning or you could put it at the end. You could put it at the end because you've come up with the theory and the law at the end. Or you could put it at the beginning as a knowledge base that you're giving them to work from, so to start.	Theoretical	Builds off of prior statements; proposes argument with evidence	Cumulative reasoning
Meagan:	So either we make two copies of them or leave them off and put them on the side of the page.	Practical	Poses argument	
Patricia:	I get the feeling that you could arrange these in a lot of different ways. Like it really depends on what you're going to teach.	Theoretical	Synthesizing the arguments	Beginning to connect the theoretical to the practical

In summary, the small group interactions reflect the creation of a "group space", which the whole class discussions did not generate despite the instructor's efforts. The group members demonstrated social competencies (e.g., listening and relating to each other), revealed cognitive competencies (e.g. prior knowledge) and showed interest in the activity (e.g., being on task and articulating quality arguments). Affect, whether positive or negative, activated or not, has been shown to impact small group interaction in upper-elementary math tasks [17]. Cartney and Rouse [18] emphasize the importance of the "emotional life of the group" which is distinct from the affective states of individual members, thereby suggesting that the group itself must be understood as co-constructing affect. Similarly, Barron [19] proposes a "dual-space" model of collaboration in which groups must attend to and develop the "content space" (the problem to be solved) as well as the "relational space" (the challenges based on social interactions within the group).

The interaction patterns of this study's small group work indicate the collective construction of a "triple problem-solving space"[20] in which content, social/relational, and affective components were developed on a moment-by-moment basis and balanced appropriately in order to engage meaningfully in the group and with theoretical topics. Didthe small groups of this study work better than the whole class at sustaining theoretical topics because there was room for the triple space to develop? The interaction patterns of the whole class discussions point towards formation of a triple problem-solving space only after PSTs' affective component were aroused – triggering of situational interest for practice-oriented topics.

IV. CONCLUSION

Learners bring various kinds of individual resources such as prior content knowledge and skills, social competencies, and interest to the demands of activities in small groups and whole class discussions. Tracing the way these kinds of individual learner resources influence group construction of the triple problem-solving space in small groups and whole class discussions will allow to take an analytical perspective to identify dynamics driving both instructional strategies rather than the more typical descriptive approach of most research on small group work [21] or research focusing solely on content analysis of whole group discussions[22]. If groups fail to manage any of these three aspects of the collective space, group collaboration will be unsuccessful, and learning – even from a well-designed task – is likely to be minimal.

Knowledge of how to scaffold learners' cognitive, affective and social resources through appropriate instructional designs will allow to flesh out ways to facilitate students' productive participation in small groups and whole class discussions while at the same time "providing opportunities for students to negotiate ways of participating that are meaningful to who they are and want to become" [23].

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