The Epistemography of an Urban and Regional Planning Practicum: Appropriation in the Face of Resistance

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> The reconstruction of society must begin with man's re-education. Its starting place is in "the extension of knowledge . . . the investigation of things," in insight, study, and learning.
>
> —John Friedmann, 1973, p. 27

We live on an urban planet. For the first time in history, a majority of us live in cities. How we grow those cities, how we build neighborhoods, how we provide housing, how we choose to get around, how well we incorporate nature into the places we live—these are the challenges that will largely determine our future. As John Friedmann (1973) noted, our changing society requires a new kind of education where knowledge is extended and people are trained to think about and address the complex problems inherent in city planning and growth.

One group of professionals tasked with addressing several of these challenges is urban planners. Because no planning solution works for every place, the training of urban planners must reflect the diversity of challenges, tools, and solutions that planners encounter in their practice. One way that professionals, including urban planners, are trained is through a practicum (Schön, 1983, 1987), a process by which newcomers are initiated into a professional community of practice. A practicum environment is explicitly designed to forge the links between knowing and doing that are central to the reflective practice of a profession. In a practicum, novices extend their knowledge and tackle complex problems. Measuring learning in a practicum environment can be challenging, however, and a growing body of research suggests that a new method called epistemic network analysis (Shaffer et al., 2009) can inform our understanding of how professionals-in-training learn in a practicum environment.

In this paper, I describe an ethnographic study of a graduate-level practicum at a large Midwestern university in order to examine one of the ways urban planners develop expertise. The graduate students in the practicum were guided in the production of a site plan for a developing area by a planner with 34 years of planning experience. In the study, I used epistemic network analysis to examine the presentation feedback sessions in order to explore emergent relationships between the teacher's planning expertise and the students' expertise. These results have the potential to influence the future design of professional practicum environments as well as the broader landscape of education.

Theoretical Background

A major goal of educators is the creation of instructional contexts in which students master skills and appropriate them as their own (Herrenkohl & Wertsch, 1999). Mastery and appropriation, according to Wertsch and Polman (2001), are part of mediated action—human

action that is fundamentally characterized by a tension between active agents and the cultural tools they use to carry out action. Wertsch and Polman defined mediated action as a form of action such as speaking, reasoning, or calculating, which inherently involves agents actively using cultural tools. Herrenkohl and Wertsch stressed that mastery of a cultural tool involves having the skill to use a cultural tool effectively, "knowing how" as opposed to "knowing that" or, in other words, procedural versus declarative knowledge. In contrast, appropriation focuses on an agent's tendency to use a cultural tool, which can be distinct from the level of mastery involved. Using Bakhtin (1981) as a base, Herrenkohl and Wertsch claimed that appropriation means to adopt, imitate, or pick up someone else's accent. Thus, appropriation is a process of making something—such as a historical narrative, an accent, a way of thinking, or an approach to a problem—one's own.

High levels of mastery are frequently associated with appropriation; however, some forms of mediated action are characterized by mastery, but not appropriation, of a cultural tool. Bakhtin argued that cultural tools are often not easily and smoothly appropriated and that although an agent might use a cultural tool, the agent might use it with a feeling of resistance or even outright rejection. Wertsch (1998) argued that when such resistance grows sufficiently strong, the agent may refuse to use the cultural tool altogether, but also noted that "it has become increasingly clear that interactional contexts involving resistance and rhetorical opposition may provide some of the most productive settings for developing mastery and appropriation of cultural tools" (p. 182).

Herrenkohl and Wertsch (1999) believed that one of the most effective ways to foster the appropriation, and not just the mastery, of cultural tools is to coordinate these cultural tools with sociocognitive roles. They claimed that sociocognitive roles can be understood in terms of rights and responsibilities, through which people have opportunities to exercise their rights as a way of being responsible to their community. Herrenkohl and Wertsch offered the example wherein a building inspector exercises her right to stop construction on a building because the contractor is suspected of using subpar materials. In this example, the inspector is exercising a right in the context of her responsibility to protect public safety. Or, put simply, she is performing her job.

Herrenkohl and Wertsch (1999) proposed that by promoting the idea of "doing one's job" and emphasizing the responsibilities to one's community and the set of rights that accompany those responsibilities, educators could induce students to practice skills important to the sociocognitive role and begin to master and appropriate them. Unfortunately for educators hoping to introduce sociocognitive roles into their classrooms, Herrenkohl and Wertsch did not outline a specific process for creating the sociocognitive roles or offer suggestions about the types of skills that could be mastered or appropriated through students' assuming roles.

Schön (1983, 1987) argued that, in most professions, people begin to master and appropriate skills in professional practicum experiences. In a professional practicum, novices engage in simulations of professional work. Their work is guided by repeated and explicit reflection, with peers and mentors, on the actions they take in these simulations—what Schön referred to as reflection-on-action. The process of explicit reflection-on-action allows one to look back on a completed task or process to consider the implications and consequences of actions.

Schön argued that the goal of the professional practicum is to bind action and reflection together to produce professional expertise particular to each profession.

Extending Schön, Shaffer (2004a, 2004b, 2006) has argued that a professional practicum is a key step to developing the epistemic frame—or the ways of knowing, of deciding what is worth knowing, and of adding to the collective body of knowledge and understanding—of a particular community of practice. In a practicum environment, experienced mentors explicitly reflect-on-action as a way to model the epistemic frame of a profession. For novices, iterative cycles of action and explicit reflection-on-action with peers and mentors bind together the elements of the epistemic frame—the skills, knowledge, values, identity, and epistemology—that an individual takes on as a member of a community of practice. This collection of cultural tools forms the epistemic frame of the community, which, once appropriated, can be used when an individual approaches a situation from the point of view (or in the role) of a member of the community (Shaffer, 2004a, 2004b, 2005, 2006).

Thus, Schön (1983, 1987) and Shaffer (2006) used a model of learning in a professional practicum that involves iterative cycles of action, explicit reflection-on-action, and the construction of a profession-specific epistemic frame. Their model extends Herrenkohl and Wertsch's (1998) assertion that coordinating cultural tools with sociocognitive roles can lead to both mastery and appropriation. Specifically, Schön and Shaffer move beyond a conversation about rights and responsibilities into a discussion about designing professional practica and building epistemic frames. However, the model of learning Schön and Shaffer used does not address the role resistance plays in the mastery and appropriation of an epistemic frame.

Although it is possible, and often quite important, to analyze how well students and others have mastered a cultural tool, such analyses can be quite limited in that they do not consider all of the complexities in the relationship between agents and the cultural tools they use (Wertsch, 1998). Thus, measuring appropriation in a practicum setting requires analysis of the process over time to see if there are instances of resistance that inhibit the appropriation of the epistemic frame. One way to analyze those components is through an epistemography, an analysis of the structure of a professional practicum through the lens of epistemic frames where one can examine the kinds of action and reflection-on-action that develop the epistemic frame of a profession (Hatfield, 2008; Shaffer, 2005). An epistemography allows one to see learning principles at work and to recognize some features of the practicum as more essential than others in developing the professional epistemic frame. However, as Wertsch noted, the relationships between agents and their use of cultural tools are complex, and traditional statistical methods do not account for the complexities.

The kinds of professional understanding that a practicum develops are complex because they are not merely a collection of disconnected skills and knowledge. Rather, the power of an epistemic frame is in the connections among its parts, a network that consists of relationships among conceptual, practical, moral, personal, and epistemological parts (Shaffer et al., 2009). Thus, analytical methods such as social network analysis provide a robust set of tools for representing networks of relationships, including complex and dynamic relationships of the kind that characterize epistemic frames (Shaffer et al., 2009). In social networks, individuals are

considered nodes in the network, and relationships between individuals are represented as arcs or links between nodes (Haythornthwaite, 1996). For example, a social network analysis of an urban planning practicum might examine the relationships among students and the teacher throughout class meetings. Within each class session, different configurations might emerge as old friends connect, new friendships emerge, and different team projects occur. The amount of time individuals spend with each other can be taken as a proxy for the strength of their relationship by analyzing the different connections among and between nodes and links. That type of analysis would provide a quantifiable way of comparing social relationships across time and a means for better understanding the informal information flows that supplement the formal practicum curriculum.

However, as Shaffer et al. (2009) argued, social network analysis was developed to provide insight into relationships among and between individuals and groups, rather than relationships within the conceptual, practical, moral, and epistemological world of an individual. Therefore, building on social network analysis, Shaffer et al. developed epistemic network analysis, a computational modeling technique for the development of epistemic frames.

Epistemic network analysis is based on two key concepts: (a) thinking can be characterized by the application of an epistemic frame composed of the linkages between professional skills, knowledge, identity, values, and epistemology; and (b) the development of professional thinking can be quantified, analyzed, and visualized through use of a dynamic network model of the developing epistemic frame (Shaffer et al., 2009). Epistemic network analysis has been used to trace frame development in elementary and middle school students during epistemic games based on engineering and urban planning (Nash & Shaffer, 2008; Nulty & Shaffer, 2008). A preliminary reanalysis of qualitative data collected on a science journalism practicum suggested that epistemic network analysis would be a useful tool for analyzing epistemic frame development in professional practica (Hatfield, 2008; Shaffer, 2005).

This study extended the ideas of Wertsch, Schön, and Shaffer by examining the relationships between appropriation, resistance, reflection-on-action, and epistemic frames in a professional planning practicum. The aim of this study was to uncover the learning process within a graduate urban planning practicum. In particular, I investigated how one teacher communicated his urban planning epistemic frame in the face of resistance, describing the students' initial resistance to the teacher's frame, the teacher's explicit reflection-on-action, and the students' ultimate appropriation of the teacher's frame. I used epistemic network analysis to examine the teacher's role in the students' epistemic frame development by tracking how specific features and events in the practicum led to significant changes in frame development. In this paper, I argue that epistemic network analysis can provide a computational model of the extent to which participants appropriate the ways of knowing, being, talking, and acting that characterize a particular community of practice. In closing, I discuss how the results of this study could contribute to the design of reflective learning environments and experiences that promote the development of the next generation of urban citizens.

The Ethnographic Study of the Practicum *Urban and Regional Planning 912*

The main goal of this ethnographic study was to explore the learning processes experienced by the 20 graduate students in the 3-credit practicum course, Urban and Regional Planning (URPL) 912. URPL 912, a prerequisite to entering the professional field of planning, met approximately 3 hours each week for 14 weeks. The teacher during the semester under study was a professional planner with 34 years of planning experience across the United States.

According to his syllabus, the course was designed to

> help prospective professional planners understand what is involved in the design and execution of complex planning projects. . . . [and focus] on the skills needed to succeed in planning practice, including work programming, gathering specific information needed to prepare a plan for a small area, working as part of a team, and making presentations.

In the course, 20 graduate students in the URPL master's program prepared a site plan for a developing area of approximately 3,000 acres on the northeast edge of Madison, Wisconsin. In the syllabus, the teacher wrote that he expected the students to "read the landscape" and to expand on the city's draft neighborhood plan for the area. Class sessions included teacher lectures, class discussion, visits by professional planners, teamwork, student presentations, and feedback on presentations (see Table 1).

Table 1
Topics and Activities in Urban and Regional Planning 912, by Week

Activity	Week number													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Overview														
Teacher lecture	1	2			4			5	6	7				
Guest speaker														
Class discussion			3							8				
Teamwork														
Student presentations														
Feedback on presentations														

Note. Topics: 1 = mental model of planning; 2 = history of planning; 3 = possible research topics; 4 = process; 5 = stakeholders; 6 = purchase and transfer of development rights; 7 = creating a plan; 8 = final product format.

To prepare the site plan, each student participated in two different teams over the 14 weeks. Students worked in their initial teams in Weeks 2–5 and in their final teams in Weeks 6–14. During the initial weeks, teams gathered background information on the site and were organized around topics such as infrastructure, existing plans, and transportation. During the final weeks, teams worked on the plans for specific areas within the site. For example, one team was responsible for the open space component of the site plan whereas a second team designed the Burke Station node in the northwest corner of the site. During Week 14, the students presented their site plans to city officials and urban planning professionals, including URPL faculty members.

Data Collection

Data were collected in several ways. I observed all 14 class sessions. During the practicum, the students worked on a site plan, and I joined the final team focused on the development of the southwest section of the site. This team included six students (two males, four females). Additionally, I received access to the course website, which included all course readings, a discussion board, a map server, and all assignments turned in by the students. The teacher also shared the comments he gave the students on their midterm examinations and met informally with me to discuss the progress of the class.

I made digital audio recordings and supplemented these data with field notes. Recordings were transcribed to provide a detailed record of interactions, and field notes were used to capture meaningful nonverbal aspects of the context and to supplement the transcripts. No information on specific career plans was collected; however, several students mentioned plans to pursue planning in city departments, nonprofit groups, and state agencies. No other demographic information was collected about the students.

Data Analysis

The data were segmented into interactive units defined as strips of activity with a consistent interactional structure and topical focus. For example, if the class started discussing the capacity of a proposed wastewater treatment plant and then switched to discussing the location of bike and pedestrian paths, the switch in discourse topic would indicate two separate interactive units. If an interactive unit represented more than one category, it was coded for all applicable codes. Within each interactive unit, the students' comments were coded cumulatively instead of individually in order to compare the students' cumulative frame to the teacher's frame.

This study's goal was to observe students learning to become planners through participation in a practicum. To capture interactions between the expert teacher and the novice students, I focused on the communication between the teacher and the students during presentation feedback sessions. Presentation feedback sessions were occasions for the teacher and the students to offer feedback on information that teams collected and for the teacher to explicitly reflect-on-action. Those sessions occurred in four classes during the semester (Weeks 4, 5, 11, 13). I analyzed data from the presentation feedback in Weeks 4 and 5 because the feedback given during those weeks focused on the information needed to create successful site plans. (Feedback given in Weeks 11 and 13 focused more on the logistics of preparing for the final presentations.) The specific activities in Weeks 4 and 5 are outlined in more detail in the Results section.

I used the teacher's epistemic frame in Week 4 as the comparative model for the students' cumulative epistemic frame in both Weeks 4 and 5 for two reasons. I was interested in seeing if the epistemic frame the teacher used during Week 4 influenced the students' epistemic frame in Week 5. Additionally, after giving the initial lecture in Week 5, the teacher did not contribute as much as in Week 4. To measure the teacher's contribution in Weeks 4 and 5, I coded interactive units for the presence of the teacher's comments.

The segmented interactive units were coded for the presence of resistance to determine whether students were resisting the teacher's epistemic frame. Data were coded for resisting the teacher's frame when students discussed or explicitly referred to their conception of how the process should progress in a way that was contrary to the teacher's conception of how the process should move forward. In this excerpt, for example, a student asserted his idea about how he thought the process should proceed:

> I sort of got the sense that they [the city staff] want us to deliver to them a set of policy recommendations and other higher level stuff to help them move this process along rather than [delivering] our own design.

The segmented interactive units were coded for the presence of reflection-on-action to determine whether the teacher explicitly reflected-on-action. Data were coded for this action when the teacher looked back on a completed task or process to consider the implications and consequences of actions, as in this example:

> I'm just saying that when you look at the land use pattern, based on uses like that quarry, there's real limitations on residential in a large part of the area. You have to think about, what are you going to do on the north end where squeezing residential in is not so obvious or so easy? . . . Maybe this needs to be a place with a real employment center instead of just [being] a bedroom community. I'm not saying that you don't have residential, and I'm not even saying you necessarily start in one place or the other, but I'm saying that it's gotta be in the thought process here.

The segmented interactive units were also coded for different skills, knowledge, values, and epistemologies of a planning epistemic frame. Though segmented interactive units were coded for identity, the identity component of the epistemic frame is beyond the scope of this paper. The skills, knowledge, values, and epistemology frame elements were broken into sub-elements in order to see a more complete picture of which specific sub-elements differed between the students' and the teacher's epistemic frames. The coded segments were aggregated into a database of interactive units showing the presence of the teacher comments, student resistance, teacher reflection-on-action, and teacher and student epistemic frame elements. The relationships among these different components were then analyzed using epistemic network analysis to identify salient themes. Definitions for each sub-element and examples of how each category was used in this analysis are found in the subsections following.

Skills. Segments were coded S/L (*skill* of reading a *landscape*) when participants discussed or explicitly referred to using the landscape to inform the planning process. For example, in this excerpt, the teacher appealed to the skill of reading a landscape by telling students:

> I [think] that it's very important that we step back and say, "How does this landscape speak to us?" rather than letting someone else give it to us.

Segments were coded S/A (*skill* of suggesting *alternatives*) when participants discussed or explicitly referred to a specific strategy or an alternative way to approach creating a plan. In this excerpt, the teacher suggested alternative land use patterns:

> Shoehorning residential onto the north end won't work. Let's see if we can put some jobs up there so that the people who live further south, where it's easier to do residential development, have a place to go that's a mile away, or a mile and a half away, instead of coming down to Madison. With that, make it a more sustainable community. If you go back to your fundamental rules of sustainability, you can pull that off.

Segments were coded S/QA (*skill* of *questioning assumptions*) when participants discussed or explicitly referred to the assumptions made in student analyses. For example, in this excerpt, the teacher encouraged the students to question the assumptions under which the city was operating:

> You guys all have to make some recommendations, but I don't want us to go into this without making sure that we are comfortable with the assumptions they [the city staff] are operating under. . . . I'm not comfortable with all of the assumptions they are operating under, and I think that their assumptions are no longer evidence-based.

Knowledge. Segments were coded K/AI (*knowledge* of *additional information*) when participants discussed or explicitly referred to specific information that might be useful in creating the site plan. In this excerpt, one student discussed the additional information her team thought would be important to collect about the site:

> This is what we think is important to identify: Property values and who owns it [the property] to see if there's any correlation there. Target areas for potential development areas, etc., that we'll hopefully be working on today. Looking into changes in zoning with different incentives for developers, transfer of development rights. Existing view shed protection. We went out there, and we didn't really come across any.

Segments were coded K/P (*knowledge* of past *process*) when participants discussed or explicitly referred to the process used by the City of Madison to create a plan for the same redevelopment area. For example, one student referred to the city's process by saying:

> We saw a map of what they [the city staff] have in mind, and they already have land uses plotted out. They are presenting that to the mayor in the next few weeks. In that land use map, they have mixed-use housing and TODs [transit-oriented developments] and lower density housing, and the majority of it is also going to be lower density acreage.

Values. Segments were coded V/PI (*value* of serving the *public interest*) when participants discussed or explicitly referred to considering the needs of people affected by the planning process. In this example, the teacher appealed to the value of serving the public interest by telling the students to consider the involvement of multiple stakeholder groups:

The developer has to be involved in this association. It's not optional. They have to be part of the deal, and you are going to have to figure out what the City of Madison would say to one or more private land owners.

Epistemology. Segments were coded E/SD (*epistemic* statement about *stakeholders' desires*) when participants justified their decisions based on how they thought a particular stakeholder group would respond. In this example, a student justified his team's decisions by appealing to the desires of businesses:

Businesses that might be developing through the university or incubator or something. They are going to need production and assembly facilities. They are going to need distribution facilities. And that might not be stuff they can get either on campus or in that incubator. This might be an ideal spot for them.

Segments were coded E/UF (*epistemic* statement about principles of good *urban form*) when participants justified their decisions based on the principles of good urban form. In this example, a student justified his team's decision by discussing these principles:

The city is planning the East Wash build-out in terms of employment . . . which means that it would have to put itself on the periphery because of the land loss. They could have an office near their production facilities. We see that as a potential benefit.

Epistemic Network Analysis

After data collection, I used epistemic network analysis to examine the presentation feedback sessions during Weeks 4 and 5 in order to explore emergent relationships between the teacher's planning expertise and the students' expertise. Epistemic network analysis adapts the framework of social network analysis for use with cognitive, rather than social, elements (Hatfield, 2008; Shaffer et al., 2009). As discussed in the Theoretical Background section, Shaffer et al. (2009) developed epistemic network analysis, a computational modeling technique for the development of epistemic frames. (For details on the computations involved in epistemic network analysis, see Shaffer et al. [2009]).

Once an epistemic frame is represented as a series of cumulative adjacency matrices showing the strength of association between each pair of frame elements for a given participant in the data set, the characteristics of the network can be quantified using concepts from social network analysis, such as network density and centrality of individual nodes (Shaffer et al., 2009). The overall structure of an epistemic frame can then be quantified by computing the relative centrality of each node: the square root of the sum of squares of its associations with its neighbors, expressed as a percentage of the weight of the heaviest node in the network.

For this study, the relative centrality of each frame element and sub-element at the final time slice of the presentation feedback activity was calculated in order to compare the cumulative students' frame in Weeks 4 and 5 to the teacher's modeled frame in Week 4. Because epistemic frames consist of elements linked together with some elements more central than others, calculating the relative centrality exposed which frame elements were farther from or

closer to the center of the epistemic network (relative centrality values closer to 100) . In addition, because relative centrality is a cumulative measure of the changes in centrality to the epistemic network graph, using only the final time slice of relative centrality offered the most accurate picture of the students' cumulative frame development during the weeks studied.

The frame similarity index (FSI) was calculated using the relative centrality and allowed comparisons between the students' frame development in Weeks 4 and 5 and the frame modeled by the teacher in Week 4. The FSI was computed by using the difference between the students' cumulative final relative centrality calculations for each frame element in Weeks 4 and 5 and the teacher's final relative centrality calculations for each frame element in Week 4. The absolute value of the difference of the values was then calculated. In order to make claims about skills, knowledge, values, and epistemology as a whole, the average of the frame sub-elements (for epistemology, e.g., E/SD and E/UF) was computed, and the results were graphed as cumulative frame elements. In the radar plots shown in the sections following, the teacher's frame is represented as the origin, and the closer the students' cumulative FSI is to zero, the more closely the students' frame resembles the frame the teacher modeled in Week 4.

Results

Results of data analysis are described in the following four subsections. First, I identify and describe the interactive units in which the students resisted the teacher during Weeks 4 and 5. Next, I identify and describe the interactive units in which the teacher reflected-on-action during Weeks 4 and 5. Third, I describe the students' appropriation of the teacher's epistemic frame in Weeks 4 and 5. Last, I revisit those data using an epistemic network analysis.

Student Resistance

At the beginning of the semester, the graduate students worked in teams to gather information about the redevelopment site. During the first class session, they learned that although the City of Madison had been working on a plan for the site for 3 years, city staff had not yet presented their plan to the mayor. Also, in contrast to previous practicum courses, the students were not going to be working as consultants for the city; rather, they would be expected to "read the landscape" and expand on the city's draft neighborhood plan for the area. The students continued to learn about the site through the teacher, guest speakers from the City of Madison planning department, out-of-class site visits, meetings with city officials, and targeted Internet research. The teams were expected to present their initial findings during Week 4 and their more specific findings during Week 5.

While presenting and giving feedback during Week 4, the students referred to the approach the City of Madison was using for the redevelopment site. When the teacher suggested alternative approaches that were contrary to the city's approach, the students resisted his suggestions. Overall, in Week 4, 3 of the 11 segmented interactive units in the presentation feedback activity were coded for the students' resisting the teacher's ideas, accounting for 54% of the time when both the students and the teacher were talking about the same topic. The dark segments within the presentation feedback section of Figure 1 represent interactive units when the students resisted the teacher. Though the entire segment is shaded, the students were not

necessarily resisting the teacher during the entire segment. The activities (guest speaker and presentations) shown in lighter shades on the figure occurred during the Week 4 class session but were not segmented into interactive units or coded for resistance.
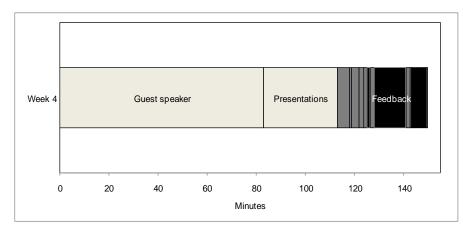

Figure 1. **Student resistance to teacher, Week 4.** Three main activities occurred during the 2.5-hour class period: guest speaker (83 min), presentations (30 min), and presentation feedback (37 min). The dark segments within the presentation feedback section represent interactive units when the students resisted the teacher's ideas (19 min). *Note.* Only feedback activity was coded for resistance.

For example, when the teacher suggested that the students look into community land trusts as potential models of a community governance organization, one student resisted the teacher's approach by appealing instead to the city's approach:

> We sort of came out of the meeting with the understanding that they [the city staff] worked hard on this for a number of years and thought long and hard about the physical layout of the area. It seems like they are looking more for us to plug in the gaps in terms of government concerns, issues like policy, how will they implement the ideas they've come up with, rather than us coming up with a design saying this is what we think it's going to look like because, frankly, there's no way that you could do all of the research that's needed to do that in a semester. I sort of got the sense that they want us to deliver to them a set of policy recommendations and other higher level stuff to help them move this process along rather than [deliver] our own design.

In other words, the student was resisting the teacher's approach to the planning problem and advocating for continuing to use the city's approach—an approach that he felt would produce results that related to the work the city staff had already accomplished and help move the city process along.

In contrast, in Week 5, the students did not resist the teacher's suggestions in any of the seven segmented interactive units in the presentation feedback activity when both the students and the teacher were talking about the same topic. In Figure 2 as in Figure 1, the activities that occurred during the class session are shown in lighter shades (teacher lecture, presentations, and teamwork) but were not segmented into interactive units or coded for resistance.
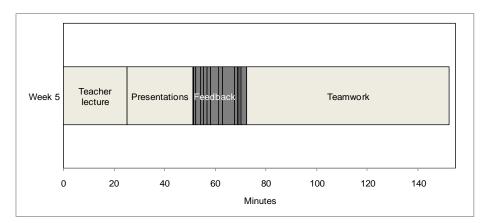
Figure 2. **Student resistance to teacher, Week 5.** Four main activities occurred during the 2.55-hour class period: teacher lecture (25 min), presentations (26 min), presentation feedback (22 min), and teamwork (80 min). The dark segments within the presentation feedback section represent interactive units; however, in Week 5, students did not resist the teacher's ideas during presentation feedback. *Note.* Only feedback activity was coded for resistance.

Teacher Reflection-on-Action

During the presentation feedback activities, the teacher often explicitly reflected on the students' findings, gave suggestions for additional information they could gather, and shared anecdotes about the similarity of the problems they were facing to problems he had faced in previous projects. In Week 4, 11 of the 12 total segmented interactive units were coded for the presence of the teacher's comments, and 8 of the 11 segments during which the teacher spoke were coded for his reflecting-on-action (shown in yellow in Figure 3). Though the entire segment is shaded, the teacher was not necessarily reflecting-on-action during the entire segment.
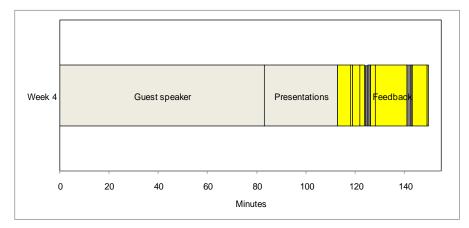

Figure 3. **Teacher reflection-on-action, Week 4.** Three main activities occurred during the 2.5-hour class period: guest speaker (83 min), presentations (30 min), and presentation feedback (37 min). The yellow segments within the presentation feedback activity represent segments when the teacher reflected-on-action (32 min). *Note.* Only feedback activity was coded for teacher reflection-on-action.

For example, after one of the teams presented the information they had gathered about the city's population projections for the site, the teacher reflected on their action by considering the implications and consequences that the information had for the recommendations they would make in their final site plans:

What you're saying is that it seems pretty comfortable. Then . . . we will talk about what that implies for traffic and other things and how those projections might change. If that's going to be what affects what we're able to propose and not propose, and if we really think those 30,000 people need to fit in there, then the question is, how do we do that? . . . How many jobs does it take to sustain 30,000 people? . . . I'm thinking as I let this area kind of settle in on me that I sense that the city was thinking about it starting with residential and then adding everything else on, and as I think about the land use pattern out there and so on, I'm not sure that's necessarily the place to start. It would be interesting to know whether jobs are projected to grow proportionally with population in Dane County and [what] any projections you can find about what job growth, employment growth look like. Because . . . one of the things that would make a big difference about what we have to plan for in this area is whether or not there are jobs there and you can have some jobs/housing balance right in that area. . . . There's the possibility of having three or four thousand jobs out there. That can make a really big difference in the land use plan out there.

By reflecting-on-action, the teacher specifically pushed the students to question the city's assumptions and to consider how the population projections would affect traffic, jobs, and the overall development trajectory. By explicitly questioning the city's assumptions and offering suggestions about how to deal with multiple possibilities, the teacher spoke directly to the students' resistance in Week 4 and strengthened the case for having the students use his approach rather than the city's approach.

In contrast to Week 4, in Week 5 the class started with teacher lecture. During his lecture, the teacher explicitly addressed the students' resistance from Week 4. He reflected on the actions the students took in Week 4 and referred to his experience as a planner in order to address the students' anxiety about using his approach instead of the city's more familiar approach:

Every planning process has to go through a period where people say . . . "I don't know what the answers are, and if I jump to conclusions now, I'm going to . . . come up with a project that doesn't work." . . . And at some point, as you gain experience, you will find that this uncertainty is no longer anxiety, it's just the way that projects go. And the reason we have a planning process, the reason that we teach ourselves this process is that we know that we're going to have to go through a period of time when we're gathering information, and you all have been doing, as near as I can tell, a fine job of collecting the information. I was pleased with what I heard in class last Friday, and I expect to, based on what I have seen, be totally pleased with what you are doing today. So, just let me reassure you that we are on course, that we are doing what needs to be done at this point in the game. And that in this experience, that the main thing, or one of the main things, that you should get out of this is some sense of the pace. And the slowest part of the

process is to gather the information, get familiar with the site, let it speak to you, and then once you've spent that time, you can sit down at your keyboard, or you can pick up your marker, and you'll know what to do. . . . I know that you're anxious, you're trying to imagine what the final product will look like . . . . We're not here to learn how to produce documents. That's something that every planner in the end acquires some skill at because it's how you report your work. But what we're here to learn about is how to think about a piece of the landscape and what might happen there.

Specifically, the teacher suggested that taking time to gather information early in the process would have positive implications for the final site plan. To address their anxieties, he encouragingly reflected on the work the students completed in Week 4, told them he was expecting to be pleased in Week 5, and assured them that although they were at a slow part in the process, they were on course. To attend to the students' concern that his approach would not relate to the work the city had already accomplished, the teacher suggested that the students

let this piece of land speak to us . . . . If we try to decide what it's going to look like before then, what you're going to end up with is exactly what you don't want to end up with, which is something that doesn't relate.

Following the teacher's lecture, the students presented the information they had gathered about the site and gave feedback on the information presented. During feedback, 8 of the 14 total segments were coded for the presence of teacher comments. In one of these eight segments, the teacher was the only person speaking, and two of the segments were coded for teacher reflection-on-action (shown in yellow in Figure 4). Though the entire segment is shaded, the teacher was not necessarily reflecting-on-action during the entire segment.
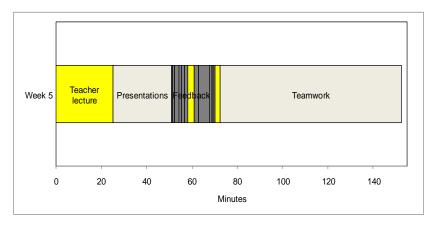

Figure 4. **Teacher reflection-on-action, Week 5.** Four main activities occurred in the 2.55-hour class period: teacher lecture (25 min), presentations (26 min), presentation feedback (22 min), and teamwork (80 min). The yellow segments within the lecture and presentation feedback sections represent segments when the teacher reflected-on-action (6 min). *Note.* Only feedback activity was coded for teacher reflection-on-action.

During the presentation feedback in Week 5, a student asked about the city's assumptions, and the teacher reflected-on-action by explicitly considering the implications and consequences that this information had for the recommendations they could make in their final site plans:

> We're simply taking the city's word. That's what they anticipate. You found that the total growth was 48,000, so 30,000 is a darn big share of that, but on the other hand, where else can Madison grow geographically? There are a bunch of infill areas that presumably a bunch of those people will go to . . . . One of the questions, although it's not a particularly simple one, is, Are the town planners correct in saying that they think they need to accommodate 30,000 people here? Are there other locations, presumably infill locations that could absorb more of that? . . . If fewer people show up, you just do less development. We'll be fine if we've set a good pattern in place.

These data suggest that by explicitly reflecting-on-action and addressing the students' resistance before they rejected his process outright, the teacher created a space where the students could begin to appropriate the epistemic frame he had modeled in Week 4.

Students' Appropriation of the Teacher's Epistemic Frame, Week 4

In this section, discussion details student appropriation of the teacher's epistemic frame in Week 4 by looking at dissimilarity of major elements of the students' cumulative and the teacher's epistemic frames. Using epistemic network analysis, the frame similarity index (FSI) was calculated to compare the students' cumulative epistemic frame with the teacher's epistemic frame. (The FSI moves toward zero for similar frames.) The total FSI in Week 4 was 165.8: The students' frame differed substantially from the teacher's frame (see Figure 5). Although the low FSI for value (based on the sole sub-element V/PI) suggests that the students' and the teacher's frames were similar, the FSIs were high for skills and epistemology and very high for knowledge, showing high dissimilarity in these areas.
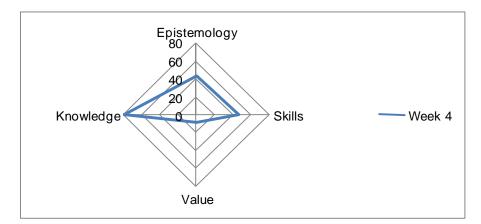

Figure 5. **Frame similarity index (FSI) for students' cumulative and teacher's epistemic frames, Week 4.** The point of origin of the radar plot (zero) represents the teacher's epistemic frame. FSI values closer to zero show similarity of frames. The FSI for *value*, for example, shows strong similarity of frames for this element.

Further separation of the epistemic frame elements into sub-elements creates a more complete picture about which specific sub-elements differed between the students and the teacher (see Table 2). Relative centrality values closer to 100 indicate that the sub-element was more central in the epistemic frame, whereas values closer to zero indicate that the sub-element was less central to the epistemic frame. For example, V/PI, S/QA, S/L, K/AI, and E/UF were the most central sub-elements in the teacher's epistemic frame. In contrast, the most central sub-elements in the students' epistemic frame were V/PI, E/SD, and K/P. In the discussion that follows, we examine only those elements in which these frames differed.

Table 2
Relative Centrality Calculations for Sub-Elements of the Teacher's and Students' Cumulative Epistemic Frames, Week 4

"Owner" of epistemic frame	Sub-element							
	S/L	*S/A*	*S/QA*	*K/AI*	*K/P*	*V/PI*	*E/SD*	*E/UF*
Students (cumulative)	0	44.72	60	28.28	91.65	91.65	100	44.72
Teacher	96.30	46.71	100	95.35	0	100	61.79	91.45

Note. Higher values (max = 100) indicate greater centrality to the particular epistemic frame. S/L = skill of reading a landscape; S/A = skill of suggesting alternatives; S/QA = skill of questioning assumptions; K/AI = knowledge of additional information; K/P = knowledge of past process; V/PI = value of serving the public interest; E/SD = epistemic statement about stakeholders' desires; E/UF = epistemic statement about principles of good urban form.

Skills. In Week 4, S/L and S/QA were central skill sub-elements in the teacher's epistemic frame (see Table 2 and Figure 6). In contrast, the students did not use S/L, and S/QA and S/A were not central to their cumulative epistemic frame. These data suggest that in Week 4 the teacher was mobilizing a different set of planning skills than the students were.
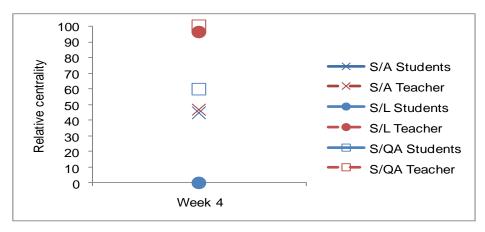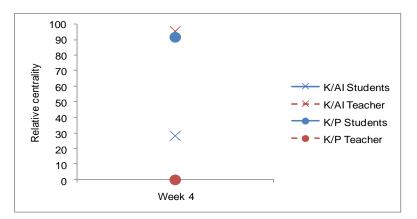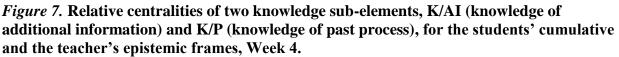

Figure 6. **Relative centralities of three skill sub-elements—S/L (skill of reading a landscape), S/A (skill of suggesting alternatives), and S/QA (skill of questioning assumptions)—for the students' cumulative and the teacher's epistemic frames, Week 4.**

Knowledge. In Week 4, K/AI was a central knowledge sub-element in the teacher's frame, but not in the students' frame (see Table 2 and Figure 7). But K/P, a sub-element the

teacher did not use, was the most central knowledge sub-element for the students. These data suggest that although the teacher was mobilizing his knowledge about what additional information might be important to gather, the students were relying on their knowledge about the city's past approach and were resisting alternative approaches.

Figure 7. **Relative centralities of two knowledge sub-elements, K/AI (knowledge of additional information) and K/P (knowledge of past process), for the students' cumulative and the teacher's epistemic frames, Week 4.**

Values. The one values sub-element—V/PI—was central in both students' cumulative and teacher's epistemic frames and is, therefore, not of interest in this discussion.

Epistemology. E/UF was a central sub-element for the teacher's epistemic frame in Week 4 (see Table 2 and Figure 8). In contrast, although E/UF was not a central sub-element for the students' epistemic frame, E/SD (epistemic statements about stakeholders' desires) was a central sub-element for their epistemic frame in Week 4.
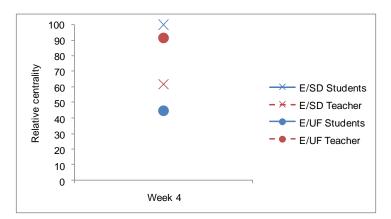

Figure 8. **Relative centralities of two epistemology sub-elements, E/SD (epistemic statement about stakeholders' desires) and E/UF (epistemic statement about good urban form), for the teacher's and students' cumulative frames, Week 4.**

These data suggest that although the teacher was justifying his suggestions by referring to principles of good urban form, the students were justifying their decisions by appealing to the desires of stakeholders, including those of the city.

Students' Appropriation of the Teacher's Epistemic Frame, Week 5

In this section, discussion details changes in student appropriation of the teacher's epistemic frame from Week 4 to Week 5 by looking at major elements of the epistemic frames, using epistemic network analysis. Figure 9 provides a summary representation of the FSI between the students' cumulative epistemic frames in Weeks 4 and 5 and the teacher's modeled epistemic frame in Week 4 (represented by the point of origin of the radar plot). As noted earlier, the total FSI was 165.8 in Week 4, but in Week 5 the FSI decreased to 90.3, suggesting that the students' frame became more similar in Week 5 to the frame the teacher had modeled in Week 4. Although there was no significant change in value development from Week 4 to Week 5 for the students, skills, knowledge, and epistemology elements in their cumulative frame shifted toward the teacher's modeled epistemic frame.
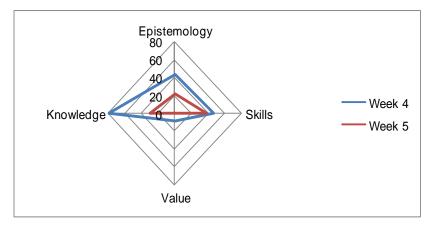

Figure 9. **Frame similarity index (FSI) for teacher's epistemic frame, Week 4, and students' cumulative epistemic frame, Weeks 4 and 5.** The point of origin of the radar plot represents the teacher's frame. As the FSI moves closer to zero, the students' cumulative frame looks more like the frame the teacher modeled in Week 4. For example, in Week 5 the FSI for the frame element *value* is zero: For this element, the teacher's and students' cumulative frames converged.

By separating the epistemic frame elements into sub-elements, a more complete picture emerged about which sub-elements became more or less central to the students' epistemic frame from Week 4 to Week 5 (see Table 3). As discussed above, V/PI, S/QA, S/L, K/AI, and E/UF were the most central sub-elements in Week 4 in the teacher's epistemic frame, whereas the most central sub-elements in the students' epistemic frame were V/PI, E/SD, and K/P. In Week 5, instead of having a strong central core consisting of V/PI, E/SD, and K/P, the students exhibited a new configuration of their epistemic frame that looked more like the teacher's, with sub-elements such as S/L, S/A, K/AI, and E/UF increasing in centrality. The order of centrality of frame elements also changed from Week 4 to Week 5.

Table 3

Relative Centrality Calculations for Sub-Elements of the Teacher's Epistemic Frame in Week 4 and the Students' Cumulative Epistemic Frame in Weeks 4 and 5

"Owner" of epistemic frame	Sub-element							
	S/L	*S/A*	*S/QA*	*K/AI*	*K/P*	*V/PI*	*E/SD*	*E/UF*
Students (cumulative): *Week 4*	0	44.72	60	28.28	91.65	91.65	100	44.72
Students (cumulative): *Week 5*	55.47	73.38	55.47	83.21	48.04	100	55.47	55.47
Teacher: *Week 4*	96.30	46.71	100	95.35	0	100	61.79	91.45

Note. Higher values (max = 100) indicate greater centrality to the particular epistemic frame. S/L = skill of reading a landscape; S/A = skill of suggesting alternatives; S/QA = skill of questioning assumptions; K/AI = knowledge of additional information; K/P = knowledge of past process; V/PI = value of serving the public interest; E/SD = epistemic statement about stakeholders' desires; E/UF = epistemic statement about principles of good urban form.

According to Shaffer et al. (2009), the relative centrality of a node within a network represents the extent to which the node is or is not part of the dense central core of the network. Thus, although some of the sub-elements became more central to the students' epistemic frame, the relative centrality values of the sub-elements in the students' frame in Week 5 were consistently lower than the teacher's. Presumably, the teacher had higher relative centrality values for frame elements in Week 4 because his 34 years of planning experience necessitated that his epistemic frame start out more richly interconnected than the students' epistemic frame. Therefore, the "looseness" of the students' cumulative epistemic frame may be due to the students' beginning to appropriate the sub-elements. Because the dense core is central to the strength of the epistemic frame, however, their epistemic frame will likely strengthen over time.

Skills. In Week 5, the students followed the teacher's model and appropriated a new skill, S/L, which became more central to their epistemic frame (see Table 3 and Figure 10). The students' use of S/A surpassed the teacher's model in Week 5, suggesting that the students moved away from relying on the city's assumptions and began suggesting multiple alternatives. The students did not show a significant change in the use of S/QA from Week 4 to Week 5.
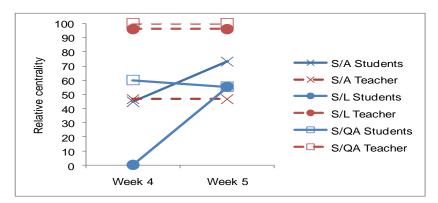

Figure 10. **Relative centralities of three skill sub-elements—S/A (skill of suggesting alternatives), S/L (skill of reading a landscape), and S/QA (skill of questioning assumptions)—for the students in Weeks 4 and 5 and the teacher in Week 4.** *Note.* Teacher data are taken from Week 4, but are repeated in Week 5 for comparative purposes.

Knowledge. The students followed the teacher's model as K/AI became more central and K/P less central to their epistemic frame from Week 4 to Week 5 (see Table 3 and Figure 11). These results suggest that the students were no longer resisting the teacher and relying on their own knowledge about the city's approach (K/P). Instead, they began suggesting alternative approaches to the site redevelopment (K/AI).
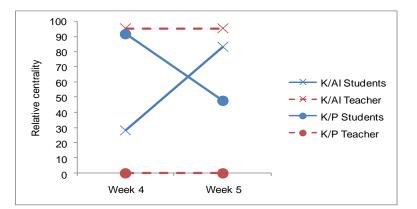

Figure 11. **Relative centralities of two knowledge sub-elements—K/AI (knowledge of additional information) and K/P (knowledge of past process)—for the students in Weeks 4 and 5 and the teacher in Week 4.** *Note.* Teacher data are taken from Week 4, but are repeated in Week 5 for comparative purposes.

Values. The one values sub-element—V/PI—was central in both students' cumulative and teacher's epistemic frames and is, therefore, not of interest in this discussion.

Epistemology. The students followed the teacher's model as E/UF became more central to their epistemic frame in Week 5 (see Table 3 and, Figure 12). E/SD became less central to their epistemic frame from Week 4 to Week 5 These results suggest that instead of appealing to the stakeholders' desires (E/SD) as their main justification technique, the students started referring more to the principles of good urban form (E/UF) and thus had a more balanced epistemology that reflected the teacher's frame.
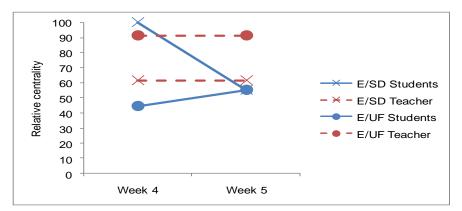

Figure 12. **Relative centralities of two epistemology sub-elements—E/SD (epistemic statement of stakeholders' desires) and E/UF (epistemic statement of good urban form)—for the students in Weeks 4 and 5 and the teacher in Week 4.** *Note.* Teacher data are taken from Week 4, but are repeated in Week 5 for comparative purposes.

Discussion

The results described in this paper suggest that examining changes in epistemic frame development across time is a useful way of seeing the process of appropriation in the midst of student resistance. Through explicit reflection-on-action, the teacher addressed the students' resistance, facilitating their appropriation of his epistemic frame.

This study extends Wertsch's (1998) work on resistance and appropriation. Wertsch wrote about the productive role of resistance in the process of appropriation, which did occur in Week 4 of URPL 912. In looking across Weeks 4 and 5, however, the results show that the students' resistance subsided and suggest that the bridge between the students' resisting and not resisting was the teacher's lecture. The teacher's lecture was essentially an explicit reflection on the different frames held by the teacher and the students and provided a map of the professional vision of the planning practice. It seems unlikely, however, that his lecture *immediately* helped the students understand the epistemic frame of planners in a new light and enabled them to put their new knowledge into practice in their presentation feedback. Therefore, the students must have started appropriating aspects of the teacher's epistemic frame in Week 4, despite their resistance.

These results also suggest that the kind of reflective mentoring in professional practicum settings that Schön (1983, 1987) and Shaffer (2004b, 2006) have described accomplishes the task of helping students appropriate a new frame in the face of resistance. Specifically, the results of this study indicate that identifying practicum activities that evoke evidence of certain aspects of an epistemic frame will provide valuable information for designing effective practicum environments and learning environments in general. For example, practitioners thinking about ways to enhance their practice might consider including iterative cycles of action and reflection-on-action, which may facilitate appropriation and mastery.

This study demonstrates that epistemic network analysis can be a productive way of tracking how specific interactions within learning environments lead to significant changes in cognitive development. Building on initial work (Hatfield, 2008; Shaffer et al., 2009), this study adds FSI to the set of techniques useful in epistemic network analysis, in this case to compare the students' cumulative epistemic frame development in Weeks 4 and 5 to the epistemic frame modeled by the teacher in Week 4. Specifically, the differences between the students' and the teacher's relative centrality values suggest that FSIs from epistemic network analysis can be useful in group comparisons and experimental studies of interventions. In other words, epistemic network analysis provides a computational model of the process and of the extent to which participants appropriate the ways of knowing, being, talking, and acting that characterize a particular community of practice. Thus, epistemic network analysis offers a powerful set of techniques for analyzing the kinds of situated understanding that result from sociocultural learning.

The study presented is, of course, limited. First, the ethnographic nature of this study necessarily means that any conclusions are limited to what one group of students and their teacher did in the context of one practicum. Second, this evidence does not support claims about

mastery in this setting or about mastery or appropriation in other settings, although examining additional data over a longer time period may expose mastery in this setting. Third, in this particular practicum, *values* (based on the sole sub-element *value of serving the public interest*) was already a central frame element for both the students and the teacher, so rather than focusing on the development of professional values, the teacher and students focused on justifying their decisions and using domain-specific knowledge and skills to make and support their justifications in Weeks 4 and 5.

Epistemic network analysis also presents its own set of limitations. Shaffer et al. (2009) have asserted that "the evolution of the epistemic network graph depends partly on the specific point in the practicum, the practicum conditions the students experience (some situations may be more likely to evoke statements of values, for example, or identities), and the changing nature of the students' actual epistemic network as it develops through these experiences." Thus, by focusing solely on the relative centrality values at the end of Weeks 4 and 5, this study tells only part of the story. Further research can examine the frame development at additional time points and under a range of practicum conditions, look at more specific subcategories of the epistemic frame elements, and examine the degree to which individual students appropriate the teacher's frame. Future work can also use epistemic network analysis to examine the causal connections between a teacher's explicit reflection-on-action and the students' appropriation of his or her epistemic frame.

Despite these limitations, this study's findings can expand epistemic network analysis to provide a computational model of the extent to which participants appropriate a professional epistemic frame in the face of resistance with the help of a mentor's explicit reflection-on-action. Thus, epistemic network analysis points towards a promising new way of observing the translation of pedagogy into practice in various types of learning environments. These findings— and future studies investigating reflective practica and the development of epistemic frames— can shed light on how to better prepare citizens to think about and address the complex problems inherent in city planning and growth. As John Friedmann (1973) noted, "the reconstruction of society must begin with man's re-education."

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