PSIHOLOGIJA, 2015, Vol. 48(2), 149–163
DOI: 10.2298/PSI1502149S

UDC 159.922.72.072

Asymmetrical peer interaction as a factor of formal operations development in more competent students

Ivana Stepanović Ilić

Institute of Psychology, Faculty of Philosophy, University of Belgrade

This paper deals with the role of asymmetrical peer interaction in the development of formal operational thinking. The relevance of the research lies in the fact that influence of peers' interaction is rarely examined in the context of the development of formal operations and in the fact that effects of asymmetrical interaction are more investigated regarding the less competent participants. The results show no influence of the interaction on the development of formal operations in more competent children. This is in accordance with some research findings. However, there are some more competent students who significantly progressed and others who considerably regressed after the interaction. That deserves attention and suggests that next important step is analysis of peers' dialogues. Such examination could reveal interaction attributes that can influence cognitive development which has theoretical relevance, but also practical implications in the classroom.

Keywords: asymmetrical peer interaction, formal operations, the more competent students

This work is a part of the research aimed at examining the role of asymmetrical peer interaction in the development of formal operational thinking. The term "asymmetrical" is related to the cognitive asymmetry between peers, since we investigated dyads formed of students with different competences regarding the formal operational thinking. In the previous study we examined the effects of cognitive asymmetry on less competent members of dyads (Stepanović, 2010). The greatest progress on the test of formal operations was registered for less competent members of dyads and pupils who were solving test items individually during the intervention phase of the research (see below in Procedure). This research, however, focuses on the peer interaction consequences on the cognitive development of the more competent dyad

Corresponding author: istepano@f.bg.ac.rs

Acknowledgement: The paper is a part of the project "Identification, measurement and development of cognitive and emotional competences important for a society oriented toward European integrations" (No. 179018) being done by the Institute of Psychology, University of Belgrade, and funded by the Ministry of Science, Republic of Serbia

members. The work relies on theoretical and research grounds of studies within Piagetian and socio-cultural approaches which dealt with the influence of peer interaction on cognitive development.

Piaget emphasized the significance of peer interaction for cognitive development in early works (Piaget, 1924/1999). Peer interaction is an encouraging setting for the transformation process of egocentric thinking in socialized form, because it is a prototype of relation without social constraint, which enables cooperation. After the discovery of sensorimotor intelligence, Piaget changed his opinion regarding the formative role of social factors in cognitive development. Despite that, he continued to claim that peer interaction is very important for emergence of logical thinking, especially for formal operations (Piaget 1941/1999, 1950/1999, 1960/1999). According to him, cooperation is the only type of social relationships which leads to the development of reflection, objectivity and critical thinking. This kind of relationship characterizes peer relations because, unlike child-adult relation, their affairs and dialogues are based on reciprocity. However, Piaget never researched effects of peer interaction. His followers recognized the importance of peer interaction for cognitive development and created rich corpus of empirical data which helped them to build a new perspective on this phenomenon (Doise, Mugny, & Perret-Clermont, 1975; Miller & Brownell, 1975; Perret-Clermont, 1993; Pere-Klermon, 2004; Psaltis, 2005a; Psaltis & Duveen, 2006).

Traditionally, Vygotskian studies were focused on adult-child interaction emphasizing the importance of their cognitive asymmetry for child's cognitive development. Vygotsky's followers developed and enriched the concept of the zone of proximal development (ZPD) specifying the tools of adult mediation (Rogoff, 1990; Trognon, 1993; Tudge, 2000; Wertsch, 1991; Wertsch, McNamee, McLane, & Budwig, 1980). Studies of peer interaction came later within this approach. The aforementioned discoveries regarding ZPD influenced those studies connecting peer interaction with educational process. In that sense socio-cultural approach considers peers as an important factor in the classroom which is understood as a learning context (Mercer & Littleton, 2007; Rojas-Drummod, Perez, Velez, Gomez, & Mendoza 2003).

Piagetian and socio-cultural approaches to the phenomenon of peer interaction converged over time. Piagetian studies emphasized the importance of peer interaction for cognitive development and started to examine socio-cognitive conflict between peers. That inspired authors within socio-cultural approach who had already investigated competence asymmetry, although between child and adult. They further developed the ZPD concept through this type of research and transferred it to studies of peer interaction. Their interest in language and dialogue strongly influenced researches within Piagetian approach. In that way, both approaches contributed to better understanding of the nature and role that peer interaction has in developmental outcomes.

The Problem

Studies of peer interaction within two approaches examined different type of interactions regarding children competencies: symmetrical (children on the same developmental level) and asymmetrical (children from different levels). Studies of asymmetrical interaction mainly focused on the less competent child and the effects of interaction on its cognitive abilities. A relatively small number of studies which followed more competent child may partly be related to the fact that authors dominantly investigated pre-operational and concrete operational children. Tudge (1989) considers the usage of conservation tasks as a problem because they do not enable registering progress of more competent children, who already reached the stage of concrete operations. Perhaps it is possible to find some reasons within Piagetian and socio-cultural theoretical framework as well. Although Piaget highlighted symmetrical nature of peer relation, he referred to the social dimension of that relation, not cognitive. His followers in the first generation of studies used his notion of cognitive conflict, applied it on peer interaction and investigated its effects on cognitive development (De Abreu, 2000; Perret-Clermont, 1993; Psaltis, 2005a, 2005b). However, as mentioned before, they dominantly used conservation task that registers development of preoperational children while formal operations were rarely examined. Research in Piagetian approach motivated authors from socio-cultural approach to expand interest from adult-child interaction to peer interaction. Since the ZPD notion assumes different cognitive abilities of interacting partners and formative role of the more competent partner in the development of the less competent one, it was understandable why they were also focused on less competent children. Behavior of the more competent children was an interesting research topic in those studies, but mainly in terms of different kinds of assistance that they provide for less competent partners. In the end it is possible that investigators were logically oriented towards less competent children trying to find out if the peer interaction could accelerate their cognitive development.

However, some researchers focused on how peer interaction affects more competent subjects even in studies with conservation tasks. Allen and Feldman (1973) reported progress of children from the transitional stage (between preoperational and concrete operational stage) interacting with less competent peers from the preoperational stage. Denessen, Veenman, Dobbelsteen, and Van Schilt (2008) examined peer interaction in older children (11–12 years old) with balance beam task similar to Inhelder and Piaget's (Inhelder & Piaget, 1958) task for testing development of formal operations. They specifically focused on different kinds of dyads, tracing medium-ability students collaborating with high-ability students, and medium-ability students collaborating with low-ability students. It was found that high ability students progressed most. Webb (2001) considers peer interaction as a very important factor for development of formal operational thinking in the classroom. In one research she examined how different group compositions with students of different or same abilities (low, medium and high) affect their performance on physics problems (Webb, Nemer, Chizhik, &

Sugrue, 1998). High ability students from that research did not regress but also did not progress when they were part of heterogeneous groups interacting with less competent partners (low or medium abilities). They only progressed when they were in homogeneous groups interacting with students who had the same competences. Fawcett and Garton (2005) examined younger children (aged 6–7) in homogeneous and heterogenous groups. In their study high ability children did not progress either when interacting with a less competent peer or with a peer who had the same competences. Tudge (Tudge, Winterhoff, & Hogan, 1996) also used adapted balance beam task and got different results for high ability students interacting with less competent partners. Namely, some of the more competent students progressed after the interaction with less competent partners and others did not, depending on the nature of their involvement in the interaction. Although Howe and Mercer (2007) claim that peer interaction in the classroom is mainly unproductive, studies of peer interaction were dominantly oriented towards development of new competences and did not analyze the phenomenon of regression. The exception is Tudge (1989, 1992) who dealt with that problem and was surprised by a large number of children who regressed after the interaction. The majority of those children were kids who collaborated with less competent partners. Tudge (1992) suggests that phenomenon of regression among more competent children may be explained by fragility of mental functions which are not fully developed. Such functions are sensitive to the context and they could be obstructed by the interaction with less competent children.

It is evident that results of studies which examined the interaction effects on more competent children are not homogeneous. Some of them registered progress of more competent children after the interaction with less competent partners. Some reported their progress, but only if they collaborated with peers form the same competence level. There are also authors who found no changes in more competent children after the interaction. However, some investigations showed regression of high ability students after the interaction with less competent peers. Having that in mind one can conclude that different kinds of predictions can be derived from empirical grounds regarding the key problem of this research. What about predictions based on two dominant theoretical approaches in this field?

From Piaget's consideration of peer interactions we can conclude that interaction with the less competent peer can be encouraging if he/she has different opinion which will trigger a cognitive conflict in more competent child and the further inner process of equilibration. Piaget states that cooperation fruitful for the development of logical thinking presupposes dialogue with common intellectual values (participants have such values or they make an effort to establish a common meaning of notions, i.e. intersubjectivity), coordination of different points of view through argument exchange (cooperation) and following the rules which ensure consistency of one's statements (Piaget, 1950/1999). Consequently, interaction that has no such characteristics should not affect cognitive development of more competent children. We can agree with Tudge (1989) that Piaget's theory does not predict regression of more

competent children after the interaction with the less competent peer. The same can be stated for Vygotsky's theory since he always emphasized formative role of asymmetrical interaction. It is mentioned that interest of socio-cultural approach for the more competent participant in the interaction was related to his/her assistance and guiding of the participant with lower abilities. Therefore it is not possible to derive precise prediction for interaction effects on the development of formal thinking in the more competent participant. However, it is well known that Vygotsky (1996) considered awareness and voluntary control as the key features of higher mental functions. That is especially important for the development of concepts' system, abstract form of thinking basically very similar to formal operations regarding its characteristics (Stepanović, 2007). In that respect we can conclude that interaction with the less competent peer may have positive effects on more competent children if it leads to higher awareness and better control of their mental functions.

Summarizing previous consideration we can state that Piagetian and Vygotskian theoretical approaches predict positive or no effect of asymmetrical interaction for the more competent participant. Empirical data collected in the investigations from both theoretical backgrounds have shown that all scenarios regarding asymmetrical interaction are possible: regression, progression and no effects on the development of more competent participant. Such state of affairs makes our examination important and very interesting, especially because this problem was not investigated much and especially in the context of formal operations development.

Method

Sample

The sample was convenient and consisted of 316 students from three primary schools in Belgrade. It was divided into two subsamples: younger primary school students, 6 classes from grade 6 (152 students, aged 12) and older primary school students, 6 classes from grade 8 (164 students, aged 14).

Procedure

The research had an experimental design: pre-test, intervention and post-test phase. In the pre-test phase the entire sample was tested by the test of formal operations BLOT. According to *pre-test* results, 47 dyads were formed. They consisted of less competent and more competent students of the same sex. Competence difference across dyads was approximately the same (around 1.5 logit units), which is accomplished by Rasch analysis. During the *intervention phase*, each dyad solved 5 test items from the parallel version of BLOT test constructed in a separate research (Stepanović Ilić, Baucal, & Bond, 2012). Each pair of students received instructions from an experimenter to solve items together and to agree on the correct solution. All dyads were video-taped. The items were chosen according to the principle that all items in the pre-test were correctly solved by a more competent student and incorrectly solved by a less competent student. The great strength of Rasch analysis is the possibility of measuring students' ability and the difficulty of items on the same on the logit scale. This means that all five items, regarding their difficulty, are below ability of a more competent student and above the ability of a less competent student (Baucal & Jovanović,

2007). One control group during this phase solved five test items from the parallel version of BLOT individually (matching items they did not solved in pre test) and other two groups did nothing (see below in Variables). One month after the interaction phase, the *post-test*, took place. The post test was the same as pre-test, original version of BLOT test translated in Serbian (see below in Instruments).

Variables

Groups in which students were classified according to the result on pre-test represent the *independent variable*. There were 6 groups: (1) E1 – less competent members of dyads; (2) E2 – more competent members of dyads; (3) C1 – students who were solving formal operations tasks individually during the intervention phase and who match less competent participants of dyads regarding pre-test results; (4) C2 – students who match less competent participants of dyads according to pre-test results and who did nothing during the intervention phase; (5) C3 group formed for the purpose of this research – students who match more competent participants of dyads according to pre-test results and who did nothing during the intervention phase; (6) the rest of the sample included children who did pre and post test but were not included in one of the previous groups.

Gender, school grades, academic and social status of pupils were treated as the *control variables*. It was mentioned earlier that dyads consisted of members of the same sex. That was necessary because many researches have shown that opposite gender of dyad members could influence the nature and results of interaction (Leman & Duveen, 1999; Psaltis, 2005a, 2005b; Psaltis & Duveen, 2006). Besides, members of all control groups were matched also with corresponding students according to the sex. Psaltis (2005a) and other investigators discovered that social and academic status of students in the classroom could also influence interaction results. On that account the effects of these variables were tested in this research, as well as the influence of school achievement. Thus the statistical control of those variables was provided.

Instruments

Formal operational thinking was examined by Bond's Logical Operations Test (BLOT). This is a multiple choice test which covers all formal operations described by Inhelder and Piaget (1958), with good metric characteristics (Bond, 1978–1979, 1980, 1989, 1995, 1997). BLOT was translated into Serbian and used for the first time in our research in 2004 (Stepanović, 2004). The results of that study showed that Serbian version had good measurement characteristics and that item parameters were very similar to those from the studies which used BLOT in English (Stepanović, 2004). As mentioned above, students and items measures on the test were obtained by the Rasch analysis and consequently expressed on the same scale in logit units. Tasks which students solved during the intervention phase were taken from the parallel version of BLOT test constructed for the purpose of this research (Stepanović Ilić et al., 2012).

School achievement was represented by the grade (from 1, the lowest, to 5, the highest) which corresponds to student's achievement at the end of the first term.

Social status was examined by sociometry technique. Namely, students were asked to choose three friends from the classroom to share a room with in a hotel on a school trip. Social status of each student was measured as the proportion between the number of times that that particular student was chosen and the number of all choices obtained within the classroom.

Academic status was also examined by sociometry technique. This time students were asked to pick three friends from the classroom to do mathematics problems with and in that way prepare for a mathematics test. The academic status was also measured as the proportion between the number of times that that particular student was chosen and the number of all choices obtained within the classroom

Results

Analysis of covariance (ANCOVA) was performed and it showed no effect of control variables (academic and social status, school achievement) on differences among groups although school achievement is near the limit (Table 1). The same situation was in the previous research (Stepanović, 2010).

Table 1
ANCOVA results

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	21.208	8	2.651	2.462	.013	.061
Intercept	.182	1	.182	.169	.682	.001
School achievement	4.038	1	4.034	3.746	.054	.012
Social status	.262	1	.262	.243	.622	.001
Academic status	1.350	1	1.350	1.254	.264	.004
Group	17.333	5	3.467	3.219	.008	.050
Error	328.424	305	1.077			
Total	398.740	314				

Therefore the ANOVA was run to test differences among groups (E1, E2, C1, C2, C3 and rest of the sample). The results show statistically significant difference among groups preformance (F(310,5)=3,209; p=0,008). The progress on BLOT test (in logit units) for each group is represented on the following figure and expressed as the differences between scores on the post-test and the pre-test.

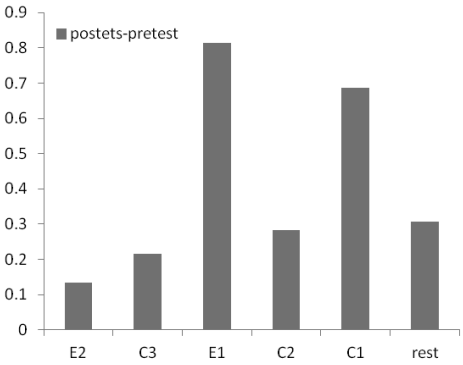

Figure 1. Groups' progress from pre-test to post-test situation within the entire sample

It is obvious that this analysis shows the greatest progress of less competent members of dyads (E1) and pupils who solved tasks individually (C1) during the intervention phase as well as in the previous study (Stepanović, 2010). Here the most interesting difference is the one between more competent members of dyads (E2) and children from the corresponding control group formed for the

purpose of this research (C3). Post hoc Scheffe's test reveals that there is no statistically significant difference between more competent members of dyads and their peers from the corresponding control group. Such finding indicates that interaction with less competent partners did cause neither progression nor regression of more competent children.

Same kinds of analyses were performed for two subsamples: younger subjects from grade 6, aged 12, and the older subjects from grade 8, aged 14. In the younger sample ANCOVA (with same covariates as for the whole sample) and ANOVA showed that there were no statistically significant differences between groups regarding their progress on BLOT test. The same results were obtained in the previous research which had less competent students in focus (Stepanović, 2010). Considering these results one more ANOVA was conducted within the younger subsample. It included only more competent members of dyads and their control group. Again there was no difference between those two groups. Within this subsample the more competent participants were not affected by the interaction with less competent peers either, except this time neither group of students progressed or regressed on post-test. The results for the second subsample i.e. older students are similar to the results obtained on the entire sample, which is again similar to the results from the previous study (Stepanović, 2010). ANCOVA has not shown an important effect of the covariates and the effect of group variable was significant (Table 2).

Table 2
ANCOVA results for the subsample of the older students

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	20.744	8	2.593	1.969	.049	.093
Intercept	.020	1	.020	.015	.902	.000
School achievement	.908	1	.908	.690	.408	.004
Social status	.596	1	.596	.453	.502	.003
Academic status	.005	1	.005	.004	.951	.000
Group	19.633	5	3.927	2.981	.013	.088
Error	202.424	154	1.317			
Total	398.839	163				

As expected, analysis of variance within this subsample reveals significant differences between groups regarding the score differences on BLOT test from pre-test to post-test situation (F(158,5)=3,644; p=0,019). Once again the largest progress is detected in the less competent members of dyads (E1) and in students who solved tasks individually (C1) during the intervention phase. In respect of the performance of more competent participants in dyads (group E2), one can notice their slight regression on the post-test (Figure 2). However, post hoc Scheffe's test has shown no significant difference between this group and corresponding control group (C3). This finding suggests that within this subsample the more competent students were not affected by the interaction with less competent peers either.

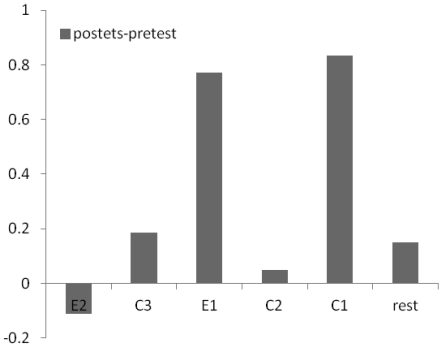

Figure 2. Score difference from pre-test to post-test situation within group of the older students

Although significant effect of the interaction on the more competent students was not found we inspected the distribution of their score differences on post-test and pre-test. Since Rasch analysis provides error for the each subject's score we considered only those differences which are outside error boundaries. As expected post-test score of majority of more competent students (n=27) is within error boundaries of pre-test score which is in accordance with our major result. Therefore Table 3 shows data for 20 more competent students whose post-test score is outside those limits. The last column of the table presents absolute value of minimal possible difference between post-test and pre-test when standard error limits of pre-test are taken into account.

Table 3
Distribution of the score difference between post-test and pre-test in more competent students whose post-test score is outside pre-test error limits

No.	SE pre-test	(Pre-test)-SE	Pre-test	(Pre-test)+SE	Post-test	P vs. R*	|d|** (logits)
1	0.46	0.19	0.65	1.11	1.31	P	0.2
2	0.41	–0.32	0.09	0.5	1.76	P	**1.26**
3	0.4	–0.48	–0.08	0.32	0.65	P	0.33
4	0.4	–0.64	–0.24	0.16	0.44	P	0.28
5	0.52	0.6	1.12	1.64	3	P	**1.36**
6	0.41	–0.32	0.09	0.5	0.87	P	0.37
7	0.48	0.39	0.87	1.35	2.24	P	0.89
8	0.44	0.01	0.45	0.89	2.24	P	**1.35**
9	0.45	0.01	0.45	0.89	–0.32	R	–0.33
10	0.44	0.01	0.45	0.89	1.12	P	0.23
11	0.52	0.6	1.12	1.64	3	P	**1.36**
12	0.56	0.85	1.41	1.97	3	P	**1.03**
13	0.44	0.01	0.45	0.89	–0.24	R	–0.25
14	0.48	0.39	0.87	1.35	3	P	**1.65**
15	0.52	0.6	1.12	1.64	2.24	P	0.6
16	0.52	0.6	1.12	1.64	1.76	P	0.12
17	0.75	1.48	2.23	2.98	1.12	R	–0.46
18	0.46	0.19	0.65	1.11	3	P	**1.89**
19	0.56	0.85	1.41	1.97	–2.19	R	**–3.04**
20	0.48	0.39	0.87	1.35	0.08	R	–0.21

Note: * P-progressed on post-test; R regressed on post-test
** |d| – absolute value of minimal difference between post-test and pre-test

Notice that 15 more competent students have better performance on post-test than on pre-test (Table 3). Their post-test scores are outside pre-test error limits and higher than scores on pre-test. Other 5 students whose scores are also outside error limits have worse performance on post-test in comparison to pre-test. One can trace the size of the difference between post-test and pre-test in the last column of the table. It is obvious that for half of the students whose data are presented in the table (n=10) that difference is relatively small ($0 \leq |d| \leq 0.5$ logits) and for two students it is a bit larger ($0.5 \leq |d| \leq 1$ logit). For others eight students with higher differences we can conclude that interaction with less competent peers affected their performance since those differences are even higher the average progression in the group of less competent students (see group E1 on Figure 2). Their post-test pre-test difference is bolded in Table 3. Five of them progressed on post-test between 1 and 1.5 logits, two progressed even more ($1.5 \leq |d| \leq 2$ logits), and one student notably regressed ($|d|>3$ logits).

Discussion

Authors within Paigetian, constructivistic, and Vygotskian socio-cultural approaches created a rich body of data related to a creation of new cognitive competences as a result of peer collaboration. This investigation should be seen in that light as well. Still, majority of those studies were directed towards less competent participants and ways that interaction affects their cognitive development. Actually, our previous study also investigated the influence of asymmetrical interaction on less competent members of dyads (Stepanović, 2010). It is mentioned that Tudge (1989) finds one reason for such orientation in the fact that conservation tasks are not suitable for tracking children beyond concrete operational stage of development. Taking that into account, it can be said that the significance of this research is twofold. On the one hand it deals with the role of asymmetrical peer interaction on cognitive abilities of more competent participants in collaboration. On the other hand it specifically examines the development of formal operational thinking. Discussing findings of some research regarding relatively low incidence of formal operations in adolescents Webb (2001) emphasizes importance of using peer interaction as a significant factor for its development in school context. However, studies investigating that issue are pretty rare. Hence the contribution of this investigation should be considered regarding its potential practical consequences on educational process.

For the purpose of registering the interaction effects on more competent students, the experimental design of the previous study (Stepanović, 2010) was enriched with additional control group that matches more competent students regarding cognitive abilities and gender. It is also important to mention that this research took into consideration other factors that, according to numerous studies, could influence the course of peer interaction and its outcomes. That is why gender has been controlled by forming single sex male and female dyads. Other relevant variables, such as school achievement as well as academic and social status within the classroom were statistically controlled.

It was concluded that relying on the theoretical foundations of two approaches similar predictions could be derived regarding the effects of asymmetrical interaction on more competent children. Therefore, interaction with no influence on more competent students, or their progression after a joint activity with the less competent peer, could be expected. Empirical data, though, suggest that all options are realistic: no effect of interaction, regression or progression. Our results have shown that asymmetrical interaction affected less competent students equally as students who solved tasks individually during the intervention phase. Both mentioned groups showed progress on post-test. However, interaction had no effect on more competent members of dyads. Their achievement did not change from pre-test to post-test. This finding is in accordance with the research regarding the influence of various group compositions on students with different competences (Webb et al., 1998). It was found there that interaction with less competent peers did not affect high ability students. They progressed only in homogeneous groups interacting with peers on the same cognitive level. Fawcett and Garton (2005) as well did not register change in more competent students regardless of whether they collaborated with peers on the same or lower level. It can be concluded additionally that our findings partly confirmed the mentioned predictions derived from approaches of Piaget and Vygotsky. It was stated that asymmetrical interaction with no influence on more competent children could be expected if their peers did not have different opinion, in the case of Piagetian theory. When it comes to Vygotskian theory, interaction would have no influence if it did not have a form of mediation through which more competent students would further develop their mental functions. Still, further analysis of dialogue features and their influence on formal operations development in more competent students would be necessary to fully test those theoretical predictions.

Besides, the influence of asymmetrical interaction on students' performance was investigated within the subsamples of different age. In the younger sample asymmetrical interaction affected neither the less competent nor the more competent dyads' members. The findings in the older sample are different and in agreement with the ones obtained from the whole sample. Performance of the more competent students remained unchanged on post-test while less competent students from dyads and those who worked individually progressed. The different findings for younger and older subjects are in accordance with other investigations dealing with various factors that can support formal operations development (Danner & Day, 1977; Kuhn, 1979; Stone & Day, 1978). They showed that this form of thinking has to be developed to a certain extent in order for particular factors to be effective.

Having in mind Tudge's observation that some of the more competent students progress after the interaction with less competent peers and some even regress (Tudge, 1989; Tudge et al., 1996), the score difference between post-test and pre-test within this group of students was thoroughly inspected. Owing to Rasch analysis we traced students whose post-test score was outside error boundaries of their pre-test score. It was concluded that interaction with less

competent peer affected primarily eight students (out of twenty of them whose post-test was outside those limits) since the difference between post and pre test was higher than 1 logit. Seven students progressed, especially two of them whose difference between post-test and pre-test score was higher than 1.5 logits. One student significantly regressed, for more than 3 logits. For the possible explanation of the interaction effect on these students it would be interesting to analyze performance of their less competent partners and characteristics of their dialogues and to compare such data with correspondent data of dyads where the more competent students were not affected by the interaction.

Conclusion

This research empirically tested effects of the asymmetrical interaction on more competent students regarding formal operational development and in that way it contributed one more relevant result to the data corpus of similar interaction studies. Although the effects of asymmetrical interaction were not found it can be concluded that investigation was fruitful because it indicates directions of ensuing studies. There is no doubt that the next step would be a more detailed analysis of interaction outcomes for both dyad members in the eight cases where more competent students progressed or regressed noticeably. After that, the focus will be dialogue analysis in different types of dyads: those where the more competent student progressed, those where such students regressed and those where their competences did not change. It was mentioned in the introduction that numerous authors within socio-cultural approach emphasize the importance of dialogue analysis since language is considered as crucial mediation means for cognitive development (Forman & Larreamendy-Jones, 1995; Kumpulainen & Kartinen, 2003; Mercer & Littleton, 2007; Rojas-Drummod et al., 2003; Rojas-Drummod & Mercer, 2003; Tudge et al., 1996). Namely, conversational analysis of dyad dialogues oriented towards less competent students in this study already gave very interesting insights and led to better understanding of obtained results (Stepanović & Baucal, 2011). For that reason dialogue analysis is equally necessary in the study of peer interaction influence on more competent students, but it is also crucial for testing relevant theoretical assumptions.

Analysis of particular cases in this study has shown that asymmetrical interaction could have positive as well as negative influence regarding formal operations development of more competent children. This finding is important because it has practical implications for the classroom as a learning setting which is significant for development of abstract forms of thinking. Teacher's knowing of each student's potential is crucial for using peer interaction as a mediation tool for formal operations development. In our opinion teachers should experiment a little by organizing students to work together or individually and discover which situation could be productive for children of different abilities. Our findings suggested that asymmetrical peer interaction and individual construction positively affected a majority of less competent students, and only some of the

more competent ones. There are researches which even discovered positive influence of peer interaction that includes two lower competence students (Schwarz, Neuman, & Biezuner, 2000). Having these different findings in mind it can be stated that a significant task for academics is further investigation of different types of peer interaction and its supportive features, while practitioners should use that knowledge and make it real in the classroom context.

References

Alen, V. L., & Feldman, R.S. (1973). Learning through tutoring: low achieving children as tutors. *Journal of Experimental Education, 42*(1), 1–5.

Baucal, A., & Jovanović, V. (2007). Critical role of the Rasch measurement in studying construction and co-construction of new cognitive competencies. Paper presented at *EARLI* conference, Budapest.

Bond, T. G. (1978–1979). Propositional Logic as a Model for Adolescent Intelligence – Additional Considerations. *Interchange, 9*(2), 93–97.

Bond, T. G. (1980). The psychological link across formal operations. *Science Education, 64*(1), 113–117.

Bond, T. G. (1989). An investigation of the scaling of Piagetian formal operations. In P. Adey (Ed.), *Adolescent development and school science* (pp. 334–341). New York: Falmer Press.

Bond, T. G. (1995). Piaget and Measurement II: Empirical Validation of the Piagetian Model. *Archives de Psychologie, 63*, 155–185.

Bond, T. G. (1997). Measuring development: Examples from Piaget's theory. In Smith, J. Dockrell, & P. Tomlinson (Eds.), *Piaget, Vygotsky and beyond* (pp. 167–182). London: Routledge.

Danner, F. W., & Day, M. C. (1977). Eliciting formal operations. *Child Development*, 48, 1600–1606.

De Abreu, G. (2000). Relationships between macro and micro socio-cultural contexts: implications for the study of interactions in the mathematics classroom. *Educational Studies in Mathematics, 41*(1), 1–29.

Denessen, E., Veenman, S., Dobbelsteen, J. and Van Schilt, J. (2008) Dyad Composition Effects on Cognitive Elaboration and Student Achievement, *The Journal of Experimental Education*, *76*(4), 363–383.

Doise, M., Mugny, G., & Perret-Clermont A. (1975). Social interaction and the development of cognitive operations. *European Journal of Social Psychology*, *5*(3), 367–383.

Fawcett, L. M., & Garton, A. F. (2005). The effect of peer collaboration on children's problem-solving ability. *British Journal of Educational Psychology, 75*(2), 157–169.

Forman, E. A., & Larreamendy-Jones, J. (1995). Learnning in the Context of Peer Interaction: A Pluralistic Perspective on Goals and Expertise. *Cognition and Instruction, 13*(4), 549–564.

Howe, C., & Mercer, N. (2007). *Children's Social Development, Peer Interaction and Classroom Learning (Primary Review Research Survey 2/1b)*, Cambridge: Cambridge University Press.

Inhelder, B., & Piaget, J. (1958). *The Growth of Logical Thinking from Childhood to Adolescence.* New York: Basic Books.

Kuhn, D. (1979). The Significance of Piaget's Formal Operations Stage in Education. *Journal of Education, 161*(1), 34–50.

Kumpulainen, K., & Kartinen, S. (2003). The Interpersonal Dynamics of Collaborative Reasoning in Peer Interactive Dyads. *The Journal of Experimental Education, 71*(4), 333–370.

Leman, P. J., & Duveen, G. (1999). Representations of authority and children's moral reasoning. *European Journal of Social Psychology, 29*(5–6), 557–575.

Mercer, N., & Littleton, K. (2007). *Dialogue and Development of Children's Thinking: A socioculutural approach*. New York: Routledge.

Miller, S. A., & Brownell, C. A. (1975). Peers, Persuasion, and Piaget: Dyadic Interaction between Conservers and Nonconservers. *Child Development*, *46*(4), 992–997.

Pere-Klermon, A. N. (2004). *Socijalna interakcija i intelektualni razvoj*. Beograd, Zavod za udžbenike i nastavna sredstva.

Perret-Clermont, A. N. (1993). What is it that develops? *Cognition and Instruction,* 11(3–4), 195–205.

Piaget, J. (1924/1999). *Judgement and reasoning in the child*. London: Routledge.

Piaget, J. (1941/1999). Logical operations and social life. In L. Smith (Ed.) *Sociological studies* (pp. 134–157). London: Routledge.

Piaget, J. (1950/1999). Explanation in sociology. In L. Smith (Ed.), *Sociological studies* (pp. 30–96). London: Routledge.

Piaget, J. (1960/1999). Problems of the social psychology of childhood. In L. Smith (Ed.), *Sociological studies* (pp. 287–318). London: Routledge.

Psaltis, C. (2005a). *Social relations and cognitive development: the influence of conversation types and representations of gender* (Unpublished Ph.D Thesis). Cambridge: University of Cambridge.

Psaltis, C. (2005b). Communication and the construction of knowledge or transmission of belief the role of conversation type, behavioral style and social recognition. *Studies in Communication Sciences, 5*(2), 209–228.

Psaltis, C., & Duveen, G. (2006). Social relations and cognitive development: The influence of conversation type and representations of gender. *European Journal of Social Psychology, 36*(3), 407–430.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* New York: Oxford University Press.

Rojas-Drummond, S. M., & Mercer, N. (2003). Scaffolding the development of effective collaboration and learning. *International Journal of Educational Research, 39*(1–2), 99–111.

Rojas-Drummod, S., Perez, V., Velez, M., Gomez, L., & Mendoza, A. (2003). Talking for reasoning among Mexican primary school children. *Learning and Instruction, 13*(6), 653–670.

Stepanović, I. (2004). The investigation of formal operational thinking on the age 14–19. *Psihologija, 37*(2), 163–181.

Stepanović, I. (2007). Porodica kao kontekst za razvoj formalnih operacija. *Psihologija, 40*(3), 417–430.

Stepanović, I. (2010). *The role of asymmetrical peer interaction in development of formal-operational thinking* (Unpublished Ph.D. Thesis). Belgrade: Faculty of Philosophy, University of Belgrade. (In Serbian)

Stepanović, I., & Baucal, A. (2011). Asymmetrical peer interaction and formal operational thinking: What happens in dialogues between peers in unsuccessful dyads? In A. Baucal, F. Arcidiacono, & N. Budjevac (Eds.), *Studying interaction in different contexts: A qualitative view* (pp. 47–90). Belgrade: Institute of Psychology.

Stepanović Ilić, I., Baucal, A. & Bond, T. G. (2012). Parallel Serbian Versions of BLOT Test: An Empirical Examination. *Psihologija*, *45*(2), 121–137.

Stone, C. A., & Day, M. C. (1978). Levels of Availability of a Formal Operational Strategy. *Child Development*, 49, 1054–1065.

Schwarz, B. B., Neuman, Y., & Biezuner, S. (2000). Two Wrongs May Make a Right ... If They Argue Together! *Cognition and instruction, 18*(4), 461–494.

Trognon, A. (1993). How Das the Process of Interaction Work When Two Interlocutors Try to Resolve a Logical Problem? *Cognition and Instruction*, *11*(3–4), 325–345.

Tudge, J. R. H. (1989). When collaboration leads to regression: some negative consequences of socio-cognitive conflict. *European Journal of Social Psychology, 19*, 123–138.

Tudge, J. R. H. (1992). Processes and Consequences of Peer Collaboration: A Vygotskian Analysis. *Child Development*, *63*(6), 1364–1379.

Tudge, J. R. H. (2000). Theory, method, and analysis in research on the relations between peer collaboration and cognitive development. *Journal of Experimental Education*, *69*(1), 98–112.

Tudge, J. R. H., Winterhoff, P. A., & Hogan, D. M. (1996). The Cognitive Consequences of Collaborative Problem Solving with and without Feedback. *Child Development, 67*(6), 2892–2909.

Vigotsky, L. S. (1996). Tool and sign in child's development. In: M. Jaroševski (Ed.) *Collected works of Vygotsky, Vol. VI*: *Scientific heritage*. Belgrade: Zavod za udžbenike i nastavna sredstva. (In Serbian)

Webb, P. K (2001). Piaget: Implications for Teaching. *Theory into Practice*, *19*(2), 93–97.

Webb, N. M., Nemer, K. M., Chizhik, A. W., & Sugrue, B. (1998). Equity issues in collaborative group assessment: Group composition and performance. *American Educational Research Journal, 35*(4), 607–651.

Wertsch, J. V. (1991). *Voices in the mind.* Cambridge: Cambridge University Press.

Wertsch, J. V., McNamee, G. D., McLane, J. B. and Budwig, N. A. (1980). The Adult-Child Dyad as a Problem-solving System. *Child Development*, *51*, 1215–1221.