ISSN 1648-3898

STUDENTS' UNDERSTANDING OF HUMAN PREGNANCY

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Abstract. *Research into students' concepts about the human body has focused on several organ systems, but the reproductive system has been largely overlooked. The few studies that addressed children's concepts of birth were conducted mainly among kindergarten or primary school children. However, no study has yet attempted to examine how adolescent students perceive human pregnancy. We administered a Human Pregnancy Understanding Questionnaire (HPUQ) consisting of 50 Likert-type items to 300 university students in Slovakia. We found several misunderstandings of human fertilization, fetus respiration, and organ development. Moreover, several misconceptions found in Slovakian primary school children in the previous research still persist in adult students. Analysis of covariance shows that students' HPUQ scores were significantly affected by gender whereas females have better scores than males. The effect of high school type attendance (with/without human biology course) did show only weak effect on students' HPUQ score.*

Key words: *birth education, pregnancy, students' understanding.*

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Introduction

Conceptions that are different from scientists are generally called misconceptions (Fisher, 1985). Misconceptions in science may be characterized as follows: they are found in males and females of all ages, abilities, social classes, and cultures. Misconceptions serve a useful function in everyday lives of people; they are often resistant to conventional teaching approaches; they interact with knowledge presented by teachers, and result in unintended learning outcomes. They resemble the ideas of previous generations of natural philosophers; they are products of direct observation, everyday language, the mass media and peer culture, and they are found frequently among teachers as well as students (Munson, 1994; Yen, Yao, & Chiu, 2004).

Yip (1998a) distinguished between misconceptions that are generated either through children's life experiences or 'naive' explanations related to more complex or abstract phenomena which are not related to personal experiences. Some misconceptions are formed as a result of a lack of understanding during instruction and other sources of misconceptions come from teachers (Yip, 1998a). Teachers may propagate incomplete or erroneous views to their students through inaccurate teaching or uncritical use of textbooks (Barras, 1984; Sanders, 1993). Thus, the identification of misconceptions held in future teachers studying at undergraduate level are necessary for improving teaching strategies used by university teachers.

Articles on the teaching of human biology have addressed a number of important issues, especially children's understanding of human bodily function (Nagy, 1953a; Gellert, 1962) and related misconceptions (Mintzes, 1984). Some researchers have examined children's ideas about particular organs or organ systems, such as brain and mind (Johnson & Wellman, 1982), digestive system (Teixeira, 2000; Rowlands, 2004), urinary system (Tunnicliffe, 2004), skeleton (Tunnicliffe & Reiss, 1999a) or whole body (Reiss & Tunnicliffe, 2001; Reiss et al., 2002; Prokop & Fančovičová, 2006). Surprisingly, few studies were focused on the reproductive system and birth. Understanding of the human pregnancy is relatively more important for girls than boys, because child development is physiologically connected with the mother. Females generally invest more into reproduction relative to males (Andersson, 1994), the importance of understanding about pregnancy should be therefore greater for females than for males. However, boys as future fathers also should have developed basic concepts about pregnancy, because they may influence prenatal period of their offspring through care they provide to the wife.

Nagy (1953b) investigated children's ideas about birth. Interviews and written responses included both US and Hungarian children between the ages 4 and 10. She found that the youngest children (especially 4 – 6 yrs old) do not know that birth does exist and life has a beginning. Some knew begins, but without the mother. Then, as the age increases, children's concepts about birth became more realistic and scientifically acceptable. Most of 8 – 10 yrs olds knew that birth is connected with the mother and a significant proportion of them also included the role of father. Similar results were obtained by Bernstein and Cowan (1975) in their follow up research. Interestingly, the children studied by Moore and Kendall (1972) studied in middle America attributed the origin of babies to divine causes.

Kreitler and Kreitler (1966) reported three theories used by 4 – 5½ yr old children about birth: the baby is created in the mother's belly from the food she eats, the baby has always existed in the mother's belly, and the baby was swallowed by the mother. In contrast to Nagy (1953b), Bernstein and Cowan (1975), Kreitler and Kreitler (1966) also asked some children what process takes place with the baby inside the mother's belly. Their responses were mostly ambiguous and hardly generalized. Up to fifty percent of children reported that the fetus grows, develops, and eats. The majority of girls, but no boys, thought that baby inside mother's belly suffer. The Goldman and Goldman (1982) made a study on children's sexual thinking in a number of different countries. They found, for example that Swedish children had attained realistic perceptions about the length of pregnancy and the birth exit by 9 years and that many children thought the anus was the baby's natural exit whilst others though a caesarean operation was the normal process.

More recently, Žoldošová and Prokop (2007) investigated birth theories of 6-10 yr olds in Slovakia about what happens with the baby inside the mother's. She used both interviews and drawings of children's ideas about prenatal development and found several misconceptions about this topic that have not been previously reported. For example, children drew the umbilical cord connected on the fetus' mouth or thought the fetus breathes through two special tubes connected to the mother's lungs. According to Slovakian children, the fetus inside uterus cannot hear or see and is placed in the mother's blood, water, or air she breathes.

In the present study, we investigated Slovakian university students' concepts of human pregnancy. This is a very interesting topic within other science phenomena, because it is either subjective to all people, but understanding of pregnancy can be obtained mostly indirectly (i.e. from media, biology lessons, books, parents, etc.). To date, however, no study attempted to investigate students' concepts of human pregnancy.

Adolescents should have basic information about human pregnancy as a result of high school or at least secndary school biology settings. However, not all high schools contain biology education in their curricula. Thus, students attending high school biology should have better understanding of human pregnancy than other students. To examine this, we decided to compare university students with various high school histories which allow us to evaluate the impact of high school biology curriculum on students' understanding of human pregnancy.

Purpose of the study

This study was conducted to assess Slovak students' understanding of human pregnancy with respect to gender and high school type. The study focuses on the following questions:

1. Is there any difference between the mean scores of males and females on the eight dimensions of the human pregnancy understanding questionnaire?
2. Is there any difference between the mean scores of students attended high schools with human biology included to biology curricula in comparison with students that did not attend the human biology course?

Methodology of Research

University students studied to be primary or secondary school teachers. They came from various types of high schools, so their academic experiences with human biology and prenatal development differ. Each student was asked to write their sex, age and type of graduated high school. In Slovakia, all school age pupils taught about the human pregnancy when 12/13 year old (grade 7 in secondary school). However, biology is not taught in each type of the high school. Thus, the type of high school was then coded as school with biology course (123 females and 23 males) or without biology course (112 females and 30 males, 12 unclear), because prenatal development is part of this subject in Slovakia. This allows us to examine the potential effect of school environment on students' understanding of pregnancy.

The study was conducted in October 2005, when the university students were not affected by any university courses that could influence their understanding of human pregnancy. A sample of 300 university 1st graders (239 females and 53 males, 8 unidentified) students completed a written human pregnancy understanding questionnaire (HPUQ, see below) to determine their understanding of human pregnancy. Students that failed to note their age, sex, siblings or school were excluded from further analyses. Age of students ranged from 18 to 23 (mean = 19.8, SD = 1.2). No one student has had own children nor was married. Although our sample was strongly female-biased, power tests showed that the power of gender differences was appropriate. We used multivariate analysis of covariance (MANCOVA) to examine factors influencing students' understanding of human pregnancy. The MANCOVA is an extension of analysis of covariance (ANCOVA) methods to cover cases where there is more than one dependent variable and where the dependent variables cannot simply be combined. This technique also seeks to identify the interactions among the independent variables and the association between dependent variables. Statistical design of this study is similar to Tuncer, Ertepinar, Tekkaya & Sungur (2004).

The Human Pregnancy Understanding Questionnaire (HPUQ)

As far as we know, no questionnaire that focuses to students' understanding of human pregnancy exists. We therefore constructed our own questionnaire consisting of 50 Likert-type items scored from 1 (strongly disagree) to 5 (strongly agree) focusing on students' understanding of human prenatal development. Several items were derived from Žoldošová and Prokop (2007) who investigated primary children's understanding of human pregnancy. The questionnaire comprises eight dimensions as follows:

1. Human fertilization (HFert).
2. Fetus organ development (FODevel).
3. Fetus respiration (FResp).
4. Importance of amniotic fluid during pregnancy (AFluid).
5. Fetus nutrition (FNutr).
6. Development of fetus' senses (FSens).
7. Fetus behavior (FBehav).
8. Mother's regimen during pregnancy (Regimen).

Half of items were formulated either positively (true items) or negatively (false items) following

Likert (1932). False items were scored in reverse order. This means that the higher the score the better understanding of human pregnancy was expressed.

Validity and reliability of the questionnaire

Three university experts reviewed the questionnaire in order to maintain validity. All were asked if the items in each dimension were relevant to the goal of the questionnaire. Revisions were based on their comments and suggestions. Reliability was calculated by Cronbach's alpha for whole test ($\alpha = 0.6$) which suggests that the scale has "moderate" reliability.

Results of Research

Effects of attending high school biology course and gender on students' understanding of human pregnancy

Multivariate analysis of covariance (MANCOVA) was used for examining effects of various factors on students' understanding of human pregnancy. Namely, high school type (categorized as with or without biology course) that students visited, and gender were used as factors. The age of each student was treated as a covariate, thus yielding tests uncontaminated by individual differences in age. A homogeneity-of-slopes GLM analysis did not reveal significant interaction between factors and covariate which suggest that their effect was similar between these subgroups. Females have better understanding of pregnancy than males ($F_{8, 276} = 5.14$, $p < 0.001$), but the effect of high school type on students' understanding of pregnancy does not show significant effect ($F_{8, 276} = 1.55$, $p = 0.29$).

Differences between dimensions (Figure 1)

A one-way ANOVA was used to measure differences between mean scores per each of eight dimensions. Mean scores significantly differ ($F_{7, 2392} = 91.2$, $p < 0.001$), while mother's regimen during pregnancy (Regimen) and the importance of amniotic fluid (Fluid) were relative better understood than other dimensions. Perhaps surprisingly, fetus respiration (FResp) acquired lowest score relative to others.

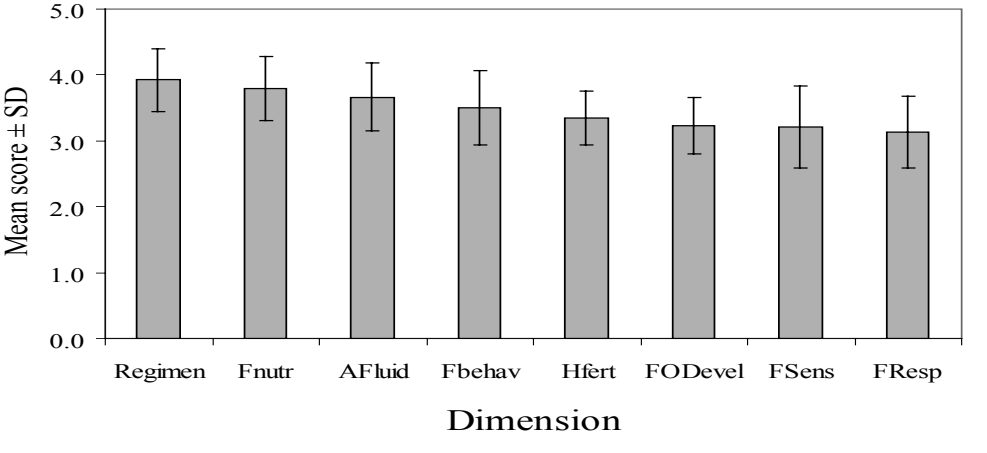

Figure 1. Mean scores of eight Human Pregnancy Understanding Questionnaire.

Students' understanding of fertilization (Table 1)

Univariate ANCOVA showed that attendance of human biology course influenced students' responses about human fertilization ($F_{1, 283} = 6.39$, $p = 0.01$). Students attending biology course reached higher mean scores than others. Detailed inspection of data (controlling for the effect of age) shows significant differences in five of eleven questions caused by gender.

Most females do know that they would have sex during pregnancy. Similarly, females are more informed about ultrasound survey than males, but, in general, only few students (13%) correctly know that it is too early during the 1st month of pregnancy. Males are more successful about the number of sperm during ejaculation or about the fusion of male and female gametes. Surprisingly, one third of students, especially females, think that ovum can be fertilized at any time ignoring time of ovulation. About half of students do not know where fertilization takes place. Similarly, only half of students are right that sex of fetus is determined immediately after fusion of male and female gamete; and 27 % of students believe that sex is determined later during prenatal development. The size of the ovum and sperm viability is also poorly understood.

Table 1. Students' understanding of human fertilization (%).

Item (True/False)	Agree	Disagree	Don't know	Higher score with respect to gender
1. Women should not have sex during pregnancy (F)	27	69.3	3.7	NS
7. The sex of child is determined in 2nd moth of pregnancy (F)	24	55.6	20.3	NS
15. Sperm inside women's reproductive tract are viable for about 48 hours (T)	55	22	23	NS
22. Fertilization occurs in the uterus (F)	39.6	47.3	13	NS
27. Number of sperm released during sexual encounter is more than 100 million (T)	59.3	15.3	25.3	Males**
33. Fertilization predominantly occurs in ovaries (F)	45.3	50.3	4.3	NS
36. The sex of child is determined during fusion of male and female gametes (T)	56.7	27	16.3	NS
40. Several sperm can enter one ovum (F)	56.3	36.6	7	Males**
42. The sex of child can be determined via ultrasound from 1st moth of pregnancy (F)	73.3	13	13.7	Females**
46. Woman's ovum is visible with naked eye (P)	22.6	56	21.3	NS
50. Woman's ovum can be fertilized at any time during menstrual cycle (F)	30	63.6	6.3	Males**

** Differences in favor better understanding of males or females at $p < .01$ level of significance (t-test for independent samples).

NS = not significant difference.

Students' understanding of fetus organ development (Table 2)

No significant effects of controlled variables were detected on students' understanding of children's organ development. As shown in Table 4, significant parts of students do not have sufficient understanding of organ development of the fetus. Relative better understanding (more than 60 % of students) was found for premature birth and start of development of organs of particular organ systems. Less than 50 % of students have the right idea about the length of the fetus, hair development, nervous and circulatory systems. Gender differences were weak.

Table 2. Students' understanding of fetus organ development (%).

Item (True/False)	Agree	Disagree	Don't know	Higher score with respect to gender
3. The length of fetus in 5th moth of pregnancy is about 25 cm (T)	48	17	35	NS
8. When is child born at 7th moth of pregnancy, it is viable (T)	63.7	32	4.3	NS
17. Hair and nails develops in 8th moth of pregnancy (F)	55.7	17.6	28.7	NS
20. Child's body is covered by little hairs in 5th moth of pregnancy (T)	39.1	15.8	45.1	Females**
23. Organs of particular organ systems started to develop at first 3 moths of pregnancy (T)	68.2	11.1	20.7	NS
32. Nervous system develops as last (F)	26.9	32.3	40.8	NS
34. Circulatory system of the mother and the fetus is mutual (T)	41.0	39.6	19.4	NS

** Differences in favour better understanding of males or females at $p < .01$ level of significance (t-test for independent samples).

NS = not significant difference.

Students' understanding of fetus respiration (Table 3)

No significant effects of controlled variables were detected on students' understanding of fetus respiration. Fetus respiration is viewed equivocally. Although the majority of students rejected the idea that the fetus is connected on a special respiratory tube, the role of the placenta was understood only by 22 % of all students. About 40 % are not sure whether the fetus breathes with lungs. Females significantly better understood embryo breathing than did males.

Table 3. Students' understanding of fetus respiration (%).

Item (True/False)	Agree	Disagree	Don't know	Higher score with respect to gender
25. Instead of fetus breath placenta (T)	22.0	44.2	33.8	NS
30. Child is connected on special respiratory tube (F)	3.7	84.5	11.8	NS
39. During prenatal development, emryo breath with lungs (T)	18.1	60.3	21.6	Females*

* Differences in favour better understanding of males or females at $p < .01$ level of significance (t-test for independent samples).

NS = not significant difference.

Students' understanding of the importance of amniotic fluid (Table 4)

Univariate ANCOVA showed that interaction between gender × school ($F_{1, 283} = 4.39$, $p = 0.03$) influenced students' understanding of the importance of amniotic fluid. Females attending biology course have better understanding about this topic than other females. Gender differences without interaction with school were not significant.

The majority of students do not know that the fetus gulps amniotic fluid, but the protective function of amniotic fluid was better understood. A significant part of students does not know whether blood is or is not inside the uterus during pregnancy. This is because blood on children after birth could reflect its presence in uterus (Žoldošová & Prokop, 2007).

Table 4. Students' understanding of the importance of amniotic fluid (%).

Item (True/False)	Agree	Disagree	Don't know	Higher score with respect to gender
4. Blood is inside uterus, child is therefore bloody after birth (F)	20.7	70.7	8.6	NS
10. Child can gulp amniotic fluid (T)	27.9	46.8	25.3	NS
14. There is silence inside uterus (F)	12.9	59.5	27.6	NS
19. Amniotic fluid protects fetus against infection and rapid shocks (T)	82.7	6.9	10.4	NS
26. Amniotic fluid regulates emryo's body temperature (T)	73.5	8.3	18.2	NS

NS = not significant difference.

Students' understanding of fetus nutrition (Table 5)

A univariate ANCOVA failed to find any significant predictors of students' understanding of fetus nutrition.

Most problematic seemed to be questions focused on the connection of the umbilical cord and the role of amniotic fluid in fetus nutrition. About one third of students think that the umbilical cord is connected on the small intestine which suggests that the relationship between placenta and umbilical cord is poorly understood. About half of students (mainly females) incorrectly feel that the fetus is fed from the amniotic fluid. Surprisingly, 14 students (4 %) think that the umbilical cord is connected on the fetus' mouth and other 7 students (2 %) don't know. The role of placenta was better understood by females in comparison with males.

Table 5. Students' understanding of fetus nutrition (%).

Item (True/False)	Agree	Disagree	Don't know	Higher score with respect to gender
2. Fetus obtains nutrition from mother's circulatory system (T)	73.0	19.8	7.2	NS
6. Umbilical cord is connected on small intestine and obtains nutrition from there (F)	36.5	34.8	28.7	NS
11. Fetus has enough nutrition in amniotic fluid (F)	46.6	38.5	14.9	Males**
16. Birth is started at that time when fetus does not have enough food (F)	8.3	74.1	17.6	NS
21. Umbilical cord is connected on emryo's mouth, by which fetus obtain nutrition (F)	4.0	94.0	2.0	NS
45. Fetus obtain the same nutrition as its mother (T)	71,6	19.8	8.6	NS
49. Fetus is feed by placenta (T)	71.6	10.1	18.3	Females**

** Differences in favour better understanding of males or females at $p < .01$ level of significance (t-test for independent samples).

NS = not significant difference.

Students' understanding of fetus senses (Table 6)

Females attending biology course reached better scores than other students ($F_{1, 283} = 4.05$, $p = 0.045$). Other effects remained non significant.

The majority of students, especially females, know that the fetus can hear voices outside the uterus. Greatest problems were found in cases of some new findings of fetus abilities. For example, only one third of students know that the fetus can dream; a similar proportion of students were right that the fetus can distinguish various tastes, or light from dark. Also, it seems that it is unclear to students whether the fetus has closed or opens eyes during pregnancy. Few students have the right idea about how the twins are connected with the umbilical cord.

Table 6. Students' understanding of fetus senses (%).

Item (True/False)	Agree	Disagree	Don't know	Higher score with respect to gender
5. Although ears startd to develop in 2nd moth of pregnancy, child hear only after birth (F)	21.6	61.5	16.9	NS
9. Identical twins have mutual umbilical cord (F)	23.9	47.1	29.0	NS
24. Fetus dreams (T)	32.2	25.6	42.2	NS
35. Fetus is able distinguish between sweet, acid and bitter taste (T)	25.1	31.9	43.0	NS
37. Fetus cannot hear us when we talk something (F)	13.2	75.6	11.2	Females**
43. Fetus has closed eyes through prenatal development (F)	56.9	27.2	15.9	NS
47. Fetus is able to distinguish between light and dark (T)	39.1	36.8	24.1	NS

** Differences in favour better understanding of males or females at $p < .01$ level of significance (t-test for independent samples).

NS = not significant difference.

Students' understanding of fetus behavior (Table 7)

Females showed significantly greater understanding of fetus behavior than did males ($F_{1, 283} = 19.04$, $p < .0001$). Other variables showed no significant effects.

As mentioned previously, students have problems with understanding whether the fetus drinks amniotic fluid. Thus, only a minority of students correctly know that the fetus can hiccup after drinking a lot of amniotic fluid. Fetus movement inside the uterus was relative well understood. About half of students were not sure about face-play of the fetus.

Table 7. Students' understanding of fetus behavior (%).

Item (True/False)	Agree	Disagree	Don't know	Higher score with respect to gender
12. Women feel fetus movement from 7th month of pregnancy (F)	29.0	65.8	5.2	NS
28. Fetus can hiccup when drink a lot of water (T)	25.0	37.6	37.4	NS
31. If the fetus movement inside uterus are too strong, there is a risk of injury (F)	13.8	78.2	8.0	Females**
41. Fetus sometimes scowl and pucker lips (T)	53.7	19.3	27.0	Females**

** Differences in favour better understanding of males or females at $p < .01$ level of significance (t-test for independent samples).

NS = not significant difference.

Students' understanding of female regimen during pregnancy (Table 8)

Females showed significantly better understanding of female regimen during pregnancy than males ($F_{1, 283} = 16.7$, $p < .0001$). Almost all students well know the effects of stress, smoking, and nutrition on fetus development.

Table 8. Students' understanding of female regimen during pregnancy (%).

Item (True/False)	Agree	Disagree	Don't know	Higher score with respect to gender
13. Mother's stress can negatively affects fetus (T)	93.7	5.8	0.5	Females**
18. Mother would smoke during pregnancy (F)	4.9	94.5	0.6	Females **
29. Mother should eat much more during pregnancy (F)	61.5	35.9	2.6	Females **
38. Diet selection during pregnancy is very important (T)	95.6	2.9	1.5	NS
44. Medicaments can negatively affect fetus (T)	63.2	25.6	11.2	NS
48. Nutrition just before pregnancy can affect fetus development (T)	50	37.4	12.6	NS

** Differences in favour better understanding of males or females at $p < .01$ level of significance (t-test for independent samples).

NS = not significant difference.

Discussion and Conclusion

Understanding of human birth and pregnancy is important for the healthy development of a new generation. Our study attempted to show effects of gender and attending biology course on the level of students' understanding of pregnancy. In summary, gender has been found to be major factor influencing what students know about the prenatal development. In contrast, the effect of biology course was equivocal.

Females scored generally better than males, but this effect was greater in topics closely related to 'practical life' during pregnancy such as foetus behaviour or female regimen during pregnancy. In contrast, males scored better in topics subjected on human fertilization. Yip (1998b) examining similarly aged students in Hong Kong reported that about 40 % of them erroneously thought that conception would be most likely to occur just before menstruation. Our study corroborates his finding, because about 30 % of students (predominantly girls) thought that fertilization can occur at any time during the menstrual cycle.

Importantly, we found no clear effect of attending biology course on students' understanding of pregnancy. Slovak biology curricula contain anatomy and physiology of human reproductive system in grade 7 (12/13 yrs old children). This also contains basic information about the prenatal development and care about newborns. However, significant part of children that left secondary school and attended high schools that not include biology or human biology in their science curricula. High school students that enrol biology course acquire deeper information about anatomy of reproductive system and human pregnancy, such as foetal developmental changes during each month of pregnancy. Thus, if the human biology in high school biology courses provides important part of students' additional understanding of human pregnancy, its effect should be evident. Contrary to this expectation, we failed to find effect of high school on students' understanding of human pregnancy. Only the interaction between school type and gender showed significant effect. However, the significance of this effect was found only in two dimensions – the importance of amniotic fluid and foetus senses.

Current studies report that schools were significantly less likely to be cited by English pupils as sources of biological knowledge about identity and taxonomic position of several species of animals

and plants (Tunnicliffe & Reiss, 1999b, 2000). Direct observations or TV/Video/CD seem to play more important roles as previously expected. Our data do not allow us to explain what sources of information are utilized by Slovak students in relation to human pregnancy, but schools probably do not play a key role. Perhaps future research in this area would provide more light on this problem.

Slovakian students' understanding of human pregnancy showed several misunderstandings from fertilization processes to foetus intrauterine development. About half of students are not clear when fertilization takes place or what number of sperm can enter the female's ovum. Foetus sex determination is not clear at least for one third of them. Development of foetal organs and organ systems or the role of placenta during foetal respiration is fairly puzzled for most students. In addition, several misconceptions found in Slovakian primary school children examined by Žoldošová and Prokop (2007) still persisted in our student sample. About 20 % of students believe that blood is inside the uterus or do not know how a fetus breathes. More than 35 % of students thought that the umbilical cord is connected on the small intestine and obtains nutrition from there. A similar proportion of students did not know whether the foetus can see during pregnancy.

In conclusion, we hope that these findings encourage both biology/science teachers and researchers to examine students' concepts of pregnancy at a deeper level. Although biology curricula contains a lot of information about human reproductive organs and prenatal development, their implementation through traditional teaching approaches into students' knowledge system seem to be less effective. Future research in this area therefore seems to be necessary.

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Received 26 June 2007; accepted 25 February 2007.

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