Experts' ways of knowing

Author
Billett, Stephen

Published
1999

Journal Title
Australian Vocational Education Review

Copyright Statement
Copyright 1999 Griffith University : This is the author-manuscript version of this paper.

Downloaded from
http://hdl.handle.net/10072/11161

Link to published version
http://www.voced.edu.au/content/ngv%3A11071
Experts’ ways of knowing


This paper reports the outcomes of pilot study that aimed to investigate how experts think act, and learn. Central to the investigation were the need to identify the role that contributions from individuals’ personal history as well as situational factors play in experts’ thinking and acting. The study comprises an investigation of three vocational experts’ characterisation of expertise, their ways of knowing and the knowledge they deployed when engaged in work-related activities. These experts are a painter, midwife and a breakdown mechanic. Drawing on other and previous work, the outcomes of this study suggest that current accounts of expertise are perhaps too narrowly defined and that situational factors and dispositional attributes need to be included if expertise is to be understood more fully. The outcomes also suggest that goals for and curriculum practice within vocational education needs to account for situational factors, the range of experiences of individuals in developing expertise and the interest and values which underpins their performance.

1. Introduction

In the last decade, a more comprehensive understanding of how individuals think, act and learn has emerged. This understanding in part is a product of a convergence between the cognitive and sociocultural constructivist perspectives that separately inform about how the internal processes of the mind and the social world contribute to individuals thinking and acting. However, together these perspectives offer the potential to understand the relationship between the social world and its influence on individuals’ thinking and acting. Such an understanding is essential for vocational education. Without a clear view of these relationships the nature of expertise; the key goal for vocational education programs may remain obscured as might identifying the most appropriate forms of instruction to develop that expertise. It is therefore salient to understand further the qualities of expertise in vocational practice in order to propose goals for practice within vocational education programs. The paper commences by exploring recent theoretical developments through advancing some propositions about how socially-derived practice and personal histories influence individuals’ thinking and acting and, hence their learning. Following this, the means of gathering and analysing the data is described. In the final section, the outcomes of the pilot study are reported and tentative conclusions are drawn from the final section.

2. Contributions to experts’ ways of knowing: Social practice and personal histories.

Complexes of situational factors that structured the performance requirements in workplaces and represented embedded versions of the socio-cultural (canonical) knowledge of the vocation of hairdressing were identified in earlier work (Billett, 1998). This led to conclusions about expertise being more situationaly-specific than is proposed in the cognitive literature and that transfer being premised on social and cultural factors as well as cognitive tools. Moreover, rather than being viewed as an objectively stateable system of knowledge, located in textbooks, fields of study or academic disciplines, domains of knowledge are held to be the interpretative product of individuals’ participation in social practice (Billett 1995). There is some evidence to suggest that
individuals’ organise knowledge using a rule-based framework premised on their personal histories. This suggests that perhaps rather than transfer from the general to the particular that transfer is really from situation to situation. In addition, associated work identified the role that dispositional factors (e.g. attitude, values, beliefs) played in the construction of individuals’ knowledge and the sourcing of those dispositions in individuals’ ontogenies or personal histories (Billett, 1997). Together, this work suggests that individuals’ socially-determined personal histories furnishes a unique set of knowledge structures which are as idiosyncratic as each individual’s life experiences as a product of engaging in particular social experiences which pattern knowledge. This view holds that rather than domains of knowledge being objective or representing some ontological truth, they comprise schemes of richly linked procedures, concepts and dispositions constructed through individuals’ life histories, through engagement in different and overlapping communities of practice (Lave & Wenger 1991). Situational factors associated with particular practice shape the embeddedness and manifestation of socio-cultural vocational knowledge. In addition, some evidence emerges of socially-determined life histories determining or selecting particular pathways, which is evident in individuals’ dispositions. Therefore, individuals’ preferences and life goals are not a desirable factor in their vocational practice, they are an essential component. Individuals’ knowledge is socially-based and patterned but in different ways because their interaction with the social world is marked by difference rather than uniformity.

The pilot project reported below, sought to determine whether deductions from the outcomes of earlier work can be extended into other domains of vocational activity. It investigates the way three experts think and act, in order to understand more fully the situational and ontogenetic contributions to individuals’ thinking and acting, how these contributions influence expertise, goals for performance and the intersection between individuals’ previous experience and the situations in which they deploy and develop further their knowledge.

One key issue is whether to view knowledge as an epistemological truth - an absolute - or whether knowledge should be seen as the idiosyncratic product of individuals' histories (Alexander, Schiller & Hare 1991). The former seem to be consistent with much of mainstream cognitive theory, through, for instance its conceptions of domains of knowledge. The latter is more consonant with the sociocultural constructivist view, which acknowledges difference in social practice, making it unlikely that domains of knowledge will ever be constructed in a uniform way. The ‘formal or absolute’ disciplinary view of knowledge (long-standing truths) can also be conceptualised as being the historically-derived sociocultural knowledge identified by Scribner (1985). However, this knowledge is disembedded from actual practice at the situational level and can be idealised or made absolute by its separation from practice. Yet, what is acknowledged as expertise is determined by the requirements of the circumstances where the knowledge is deployed (Billett 1995). Therefore, views of domains of knowledge and expertise within the cognitive literature need extending to account for the particular circumstances where knowledge is deployed (e.g. workplaces). Instead, it is proposed that individuals construct their domains of vocational knowledge through engagement in different communities of work practice within their life history.

Consequently, expertise is held to be more than the possession of socio-cultural tools or the skilful use of that knowledge; it includes how those tools and knowledge are applied in particular circumstances and activities (Billett 1995). Moreover, a hallmark of expertise is the ability to resolve non-routine problems to the satisfaction of the particular work practice. This requirement is likely to differ from one work site to another.
What is a satisfactory response in one workplace community might be viewed as indulgent or inappropriate in another. Consequently, how knowledge is deployed and problems solved are determined by the particular workplace with its goals and norms. Therefore, views about domains of knowledge and notions of expertise needs to be shifted from the sociocultural level of practice (long-standing truths - epistemological truths) to one where expertise is shaped by a complex of situational factors and requirements (Beven 1997, Billett 1995, Stevenson 1996). This is not to deny the significance of long-standing truths, or the socio-cultural level of knowledge development, but rather to highlight the importance of how these truths are constituted, manifested and transformed in particular circumstances. It also elaborates the reasons why instruction should also focus on conditions of application of the knowledge and skills to be learnt (Brown, Collins & Duguid, 1989).

Views of expertise from within cognitive psychology have focused on the idea of superior performance and have attempted to identify the particular attributes which permit such performance. Inquiry has focused on the time taken to perform in superior manner (10 years) and also means of analysis which will lend itself to standardised testing in laboratory conditions (Ericsson & Smith 1991). The idea of superior performance is attractive, but when it is taken to mean the peak of human performance (e.g., perfect musical pitch or record breaking athletic activity) it becomes less relevant to assist understanding performance in everyday vocational activities which is the concern of vocational education. Although it is informative to understand the attributes of a world champion, for vocational education it is more important to understand the characteristics which permit performance in significant non-routine problems in workplaces. However, the routineness of problems is person-dependent to some degree. Therefore, it is necessary to identify benchmarks that are non-routine yet specific to situation where the knowledge is to be deployed, yet within the realms of the individual to solve the problem. That is, it is not so ‘far’ outside of the domain of sociocultural knowledge (e.g occupational knowledge) as to make it unreasonable to expect the expert to solve the problem. For example, it might be reasonable to expect expert tailors to be able to cut a garment which addresses differences in a customer’s figure. (e.g., sway back, dropped shoulders, head forward etc etc). However, it would be unreasonable to expect them to make items of lingerie or ball gowns, because such garments are not manufacturable with tailoring knowledge. Also, views of expertise need to acknowledge situational factors that determine performance (Beven 1997, Stevenson 1996). What is an acceptable tailoring job in one place, may be inappropriate in another, and indulgent in a third. So there is no uniform way of judging the quality of the solution. Hence, the appropriateness and significance of the solution to the situation needs to be considered.

In seeking to understand superior performance, early work in cognitive psychology relied on standardised testing and those activities lending themselves to laboratory-type testing. The problem is that what is suitable for the purposes of laboratory work, may have limited application to the everyday activities which are more typical of the ‘lived-in’ world such as work. For instance, the games that feature in these experiments have solutions may not be representative of the kinds of thinking and acting required for vocational practice. There is a way to win the game of chess or solve the Tower of Hanoi problem. The goal states are clear. Yet many activities in the lived in world often do not have clear goal states. Instead, they have to be negotiated as part of the problem-solving process. So empirical convenience may not have served well the understanding of expertise in the ‘lived in’ world of vocational practice. It is proposed therefore, that the cognitive psychology constructivist
perspective to augmented by a recognition of social sources of cognition, and a clearer understanding of how these sources influence the acquisition, organisation and deployment of how experts come to know. Such an augmentation reduces the isolation of cognitive psychology from social sources of knowledge and their contributions to cognitive development. However, more than being seen as a mere context for cognition as some recent work has been criticised (e.g. Resnick, Pontecorvo, Saljo & Burge 1997), ways of knowing and key activities, such as problem-solving, learning and transfer, are shaped reciprocally by engagement in goal-directed activities in particular social circumstances (Valsiner 1994, Lawrence & Valsiner 1993). The initial organisation and structuring of individuals' representations of newly acquired knowledge are interpretative outcomes of the intersection between personal histories that are derived from ongoing participation in different social practice and the particular social practice. Therefore, individuals' representations of knowledge have idiosyncratic albeit socially-derived sources. However, engagement in social practice mediates the structuring of individuals' knowledge (Newman, Griffin & Cole 1989).

Social practice such as workplaces are instances of where individuals engage in goal-directed activity. They are held as being the arenas or activity systems (Engestrom 1993, Leonteyev 1981) in which different sources of knowledge interact. It is workplaces that individuals access and interpretatively construct socio-culturally-derived knowledge through problem-solving, thereby giving coherence to what would otherwise be idiosyncratically structured knowledge. Moreover, in acknowledging the relative nature of expertise to the requirements of the culture of practice and is embedded in socio-cultural practice; that expertise involves competence in the discourse, norms and values of practice and that expertise is reciprocal, shaping as well as being shaped by the community; and that expertise is situated and pertinent to particular problems within the community.

3. Method
In order to investigative tentatively these propositions, a pilot study was undertaken to determine to whether experts' thinking and acting draws upon situational factors and their personal history. In addition, an attempt will be made to capture the types of thinking and acting experts engage; that is how they ‘know’.

3.1 Subjects
Quite diverse examples of vocational activity were used in this pilot study to appraise the predictions about how social practice and socially-derived personal histories influenced the subjects thinking and acting. The three subjects consisted a midwife, a motor mechanic and a painter. The midwife works in a birth centre, which practices active birthing in a major metropolitan hospital. The birth centre is managed by midwives and offers the equivalent of a home birth in the security of a hospital setting. Unlike, more traditional birthing situations, the midwives offer total care and have a long-term relationship with the parents leading up to the birth. The car mechanic is self-employed and works as a contract breakdown mechanic. He was a mature age apprentice and has worked in a number of workshops both during and since completing his apprenticeship. He has quite deliberately selected workshops that offered a wide range of experiences to develop his skills with a view to be working in an autonomous, and ideally self-employed capacity. The painter is a successful artist who has exhibited around Australia, has enjoyed considerable critical acclaim, regularly sells paintings, is sought out for showings and commissioned work. He works alone, currently from a room within his residence and in a way he has done for a number of years, working long days often without a break. All three of the subjects can be
classified as experts as their work and work record suggests that they have the capacity to address significant non-routine problems within their practice.

3.2 Procedures for data gathering
The data gathering procedures were based around interviews. Data was gathered about: (i) what it means to be an expert; (ii) how they had developed that expertise; (iii) what they thought about when responding to a particular problem and (iv) a detailed description of how they went about undertaking a particular task.

Therefore, a combination of open questions and grounded examples were used to enhance the prospect of the data’s validity. For example, the midwife used detailed medical records associated with a particular birth as an aid to recall when responding to descriptions of the task and what she was thinking about. With the painter, actual paintings were used to elicit responses and an actual breakdown incidents were used with the mechanic.

The same set of questions were used for the three subject. Although slight variations were used to gather data about how they think and act during a particular incident.

The first items which focused on expertise were as follows: (i) how they conceptualise expertise (What does it mean to be an expert midwife?) and (ii) how they acquired their expertise (How did you develop your skills to be an expert?). The next set of questions aimed to understand how they used their knowledge in performing a particular task - “how they know”. The same principle of grounding the questions in their practice was adopted. However, given the different nature of their work different approaches were taken to elicit the data. For example, the midwife was played a tape of a foetal heartbeat. She was asked: What are you listening for? How are you listening - think about when you are listening? Remember back to when you were a novice midwife. - How you went about listening then? - How does that differ from what you are listening to now?

The painter was given a painting to examine and asked: What are you thinking about when you look at this painting? (How do you form a view about its worth? In what ways are you thinking about this painting when you were a novice? The motor mechanic was asked: Think about a job you undertook recently - What are you thinking about when you undertook this job - what did you decide to do with the vehicle? What are the differences in how you would have approached the task when you were a novice?

The next set of questions elicited data about how the subjects’ think and act as they undertook vocational tasks. These responses were also grounded in actual events. So, for example, the midwife used the detailed notes she had taken during a recent birth to validate the account of her thinking and acting. The painter made comments on a tape recorder as he completed a painting over a period of several days. These comments were aligned to a set of photographs taken during the development of the painting. The motor mechanic responded to a particular breakdown situation. Using the birth charts, her notes and the graphs, the midwife explicates her thinking during the birth process. The following questions were posed: What are the stages of the delivery? How do you monitor the labouring mother? In every birth, the midwife makes a series of interventions - How do you know in what ways you intervene? The painter was asked - What are the stages of the painting the picture? Describe each of these stages? With a new piece in mind - Working through each of the stages of the painting - Tell me what you are thinking about? What are you thinking about at each stage? The motor mechanic was asked:
When you are thinking about how to approach the task what are you thinking about? Is there a particular set of stages or phases involved in undertaking the task? If so what the stages involved in the task? As you are working through each of the stages of the task - Tell me what you are thinking about? What are you thinking about at each stage? The interviews were tape-recorded and transcribed to produce protocols that formed the basis for the analysis.

3.3 Data analysis
The data from the interviews were analysed in distinct ways. The data about the characteristics of expertise, how that expertise was developed, ways of knowing during a particular event were tabularised analysed using common frameworks. However, in order to analyse the responses to the problem situations (managing a birth, fixing a car, and developing a painting) the data were used initially to construct analytical frameworks for each of the activities in order to capture the different contributions to and the nature of this goal-directed activity (see Figure 1 - for an example). These frameworks furnishes views about the particular activity and how different sources of knowledge influence it. As part of the analysis, the protocols were returned to the subjects in order for them to comment, make changes etc. In addition, the analytical frameworks were taken back to subjects for them to provide comments on whether these frameworks captured their activities.

4. Findings
The findings are reported under four headings: (i) characteristics of expertise, (ii) life history and (iii) acquiring expertise.

4.1 Characteristics of expertise
Table 1 illustrates the subjects’ responses to characteristics of expertise. Although not wholly comprehensive these responses are categorised under five headings: (i) dispositions; (ii) skilfulness; (iii) audience response, (iv) situational appropriateness and (v) advancing skilfulness. Dispositions refer to particular personal attributes that are essential for performance. The mechanic referred to being ‘professional’ in approach to his work, the midwife referred to ‘confidence’ in her ability that is communicable to her birthing mothers and the painter to the ‘determination’ required to produce new work. Skilfulness was mentioned by all three subjects as was their need to continue to develop their skilfulness. To illustrate this point, the artist referred to overcoming the trepidation associated with each painting and the further development of an ability to realise his ideas, the mechanic expressed concern that by focusing on particular parts of his practice was inhibiting his ability to be competent in others. An ability to communicate to clients, enjoy the confidence of birthing mothers and standing by work warranty are taken as statements about audience response.

Table 1 - Characteristics of expertise

<table>
<thead>
<tr>
<th>Categorisations</th>
<th>Instances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispositions</td>
<td>confidence (m/w), determination (p) and professional (m/m)</td>
</tr>
<tr>
<td>Skilfulness</td>
<td>produce something which is novel (p), knowing how and when to</td>
</tr>
</tbody>
</table>
intervene (m/w) and being able to do a job on your own (m/m).

**Audience response**
critical acclaim and sales (p), mothers having confidence (m/w) and satisfying customers needs breaching warranty (m/m).

**Situational appropriateness**
managing complete care midwifery in the Birth Centre (m/w), knowing the audience (p) and managing the sequences of road breakdowns and whose diagnosis can be relied upon (m/m).

**Advancing skilfulness**
becoming better at communicating, overcoming trepidation (p), reading and practising more (m/w). rotating through different activities to maintain ability (m/m).

Notes: p = painter, m/m = motor mechanic, m/w = midwife

Situational factors were evident in each of the subjects’ response. The midwife identified a series of differences between her midwifery practice and that within a traditional delivery room in a large hospital. These differences included continuity from prenatal preparation to postnatal care, including the establishment of a relationship between a single midwife and the birthing mother. This was contrasted with a different level of care that existed in a traditional delivery ward where the midwife’s knowledge of the mother might only be through medical records and an immediate diagnosis during labour. Expertise of a different kind was evident in each situation, with midwives in a delivery ward having to appraise the mothers’ progress very quickly, having to work across a number of birthing mothers, and moving in and out of cases as their work shifts commenced and concluded.

The painter was influenced by situational factors such as his store of reference material, artefacts and life events. The mechanic employed situational factors such as the types of car breakdowns he had to attend to sequence his work activities to addressing the needs of different clients and overall satisfaction. The relative trust he placed in the diagnosis of other mechanics and the need to keep a small business solvent.

Within the category of skilfulness there was evidence of some of the now commonly accepted cognitive attributes of expertise. These included the compilation of specific procedures and chunking of concepts, with for example, the painter referring to considering the next painting while painting in the background or foliage. Equally, the midwife’s was able to diagnose the baby heartbeat without having to make a timed count. What is evident in these tentative findings is that expertise goes beyond the attributes of skilfulness referred to in the cognitive literature. Of these attributes identified - skilfulness and audience response are analogous to the cognitive view, situational appropriateness and audience response analogous to the sociocultural perspective and the dispositional view reflected in dispositions and attribute of attempting to advance skilfulness.

### 4.2 Life history

The origins of each subjects’ pursuit of their particular vocation is evident in their life history. The painter made a conscious decision at a particular point in time to become a painter, rather than be involved in other art-related activities. This was a product of a feeling of dissatisfaction with other work. As a result, he pursued a pathway of improving knowledge of and technique in painting and showing work in a very productive manner over a ten-year period. “I didn’t want to be a pretend artist”. The midwife felt an immediate affinity with this work during her nursing training, moreover, she relates this to her earlier experiences as being an eldest sister to brothers, being aware of them in invetro and caring from them as younger siblings. The mechanic had a number
of jobs prior to becoming a mechanic, including an incomplete electrical apprenticeship, had been interested in cars, had worked in a wrecker’s yard before deciding to commence an automotive apprenticeship. This decision was predicated on his assuming family responsibilities. Even so, he pursued a pathway that would provide extensive experiences and was guided by a goal of autonomous work. In brief and, in sum, each subject held a view about their personal trajectory with their vocation. Perhaps, this is a weakness of this study. That is, not all experts may share these personal goals.

4.3 Acquiring expertise

The three subjects commonly offered the view that their expertise is the result of their participation in formal educational programs and extensive experiences. Each subject claimed that different and valuable contributions have been made to their expertise by a combination of these experiences. The length of time required to gain expertise was mentioned particular by the midwife and the painter. The painter mentioned a ten to twelve year process of trial and error to improve technique to the point of being confident of realising what he conceptualised. The ongoing practice over this time period is usually described as providing opportunities for individuals to engage in goal-directed activity and in two cases have access to close guidance of more expert others. The midwife emphasised the importance on ongoing and repeated involvement with normal and abnormal birth in her preparation for autonomous midwifery practice. She describes the importance of having experienced a wide range of birthing scenarios that furnished knowing about birthing. This experience contributes to her confidence about how and in what ways to intervene. Equally, the mechanic’s decision to secure employment situations that provided a rich array of experiences to develop his skilfulness. So it seems by engaging in ongoing goal-directed activity that these experts have developed a rich knowledge base about how to deploy their knowledge in securing those goals.

With reference to the formal component of the subjects’ development, it is tempting to conclude that access to education institutions had furnished a provision of conceptual knowledge. The artist referred to understanding the place of a painting in the history of art and the use of particular symbols as being a product of participating in six years of formal preparation. The midwife noted the understanding of physiology and principles of approaches to midwifery. The mechanic referred to ideas acquired in the TAFE environment that he is able to refer back to when responding to novel problems. He even referred to going back to his notes. However, what the subjects report learning from both the educational setting and through their workplace experience have procedural and as well as a conceptual dimensions. It seems they have learnt different things in each of those settings and what they have learnt is not divisible into theory and practice - rather the different communities of practice have furnished access to different knowledge which is privileged by the particular community. What is interesting is the relationship between what has been learnt in the two settings and the different purposefulness of this relationship to each of the experts. For instance, during his six years in educational institutions the artist was never taught the techniques he now uses. His interest in representational art has evolved since graduating yet it is influenced by work he did while a student. Alternatively, the mechanic was able to access techniques and equipment in the TAFE environment, which were not used in his workplace. Also insights into the whole domain of automotive repairs were provided which he was not able to access because of his preference for
working in small garages. It seems that these experiences provided a basis to apply knowledge across different components of automotive practice. For the midwife, techniques learnt in initial preparation and insights about alternative practices have coalesced in her drive towards her active birthing process. A combination of approaches and techniques provided a critical base from which she has derived her current practice.

5. Implications for practice in vocational education

From the analysis above and the previous discussion, some implications for vocational education are identifiable. These are associated with goals for vocational education, practice within vocational education and issues of access. Firstly, and drawing on the earlier work and that of others, it is evident that the goals which drive vocational education have situational dimensions as well as those concerned with long-standing truths of the vocation. Significantly, it seems that the particular social practice influences the nature of not only what is learnt but what is taken to be goals for learning. Hence, curriculum goals and instructional practice need to consider situational factors and its influence on cognition and subsequent thinking and acting. Transfer seems to be about identifying differences and similarities between situations, rather than generic knowledge which is inherently transferable. This suggests a situated view of curriculum development and implementation. Equally, curriculum practice could focus on not only teaching knowledge in one context but how that knowledge applies to other contexts, than the one in which it is being accessed. Hence, a process focus to educational intent and practice, rather than one on outcomes is probably required. In addition, the emphasis on process is central to a consideration of the dispositions associated with vocational practice and the interest that the three subjects enunciated in maintaining and developing further their knowledge. Returning to curriculum practice, the ongoing access to goal-directed activity seems important, as each of the subjects emphasised what is stated in the literature for the need for time and repeated practice with both routine and non-routine activities.

References

Beven, F (in press). Learning in the workplace: The contextual nature of workplace competence - further research. Centre for Learning and Work Research, Griffith University, Brisbane.
Figure 1 - Expert’s way of knowing - Midwife - Birth Centre -

Situational Factors

Prior knowledge of mother
- preferences
- disposition
- pathology

Prior to admission
Underlying pathology - blood - show - history of contractions (regularity - strength); Mother’s anxiety - tone of voice - partner calling - ability to talk through contractions - preference for coming in - perception of pain threshold

During Stage 1
Vaginal examinations - frequency, woman’s skin hue, sweat, maintenance of eye contact, noise being made - contractions (frequency - discomfort) - area(s) of discomfort, mucus - blood ‘show’ - observation of mother and monitoring baby

First Stage - cervix effacing - dilatation - longest section - highly variable

Transition - colour of skin, flushed sweat, noise and association with movement (e.g pelvic rock) - grunt at the end of vocalisation, series of grunts - monitoring the baby - monitoring progress - maybe internal examination, use of mirror, position of most comfort for mother - monitoring the perineum and muscles - pressure increase

At birth - checking position of cord, blood flow, baby’s condition - need for cintosin. Checking for meconium in water

Second stage - full dilation to birth of baby

Third stage - delivery of placenta

Ante-natal care

Sociocultural knowledge of midwifery
(canonical knowledge)
Procedures, concepts, norms
- three stages of birth - Antenatal care - preparation, Birth care (facilitation) Post natal care - transition to motherhood
dilation of cervix - positions

Culture of practice
- norms of the community of practice (procedures, concepts and values)
e.g. - minimise use of vaginal examinations, length of stay

Ontogeny - midwife’s preferences shaped by personal history preference based on their experience (e.g for mothers’ autonomy reluctance to conduct internal investigations, approach to pain management and monitoring of baby.

Monitoring baby - meconium, vital signs and components
Mother’s blood flow,