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The process diary: developing capability within national curriculum design and technology - some initial findings

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Abstract

The paper describes the background to and the initial development and trialing of a Process Diary for pupils working in design and technology within Key Stage 2 and Key Stage 3. This is seen as a medium through which a pupil records her/his experiences at the time they take place. This will help the teacher in reviewing and assessing capability demonstrated by those activities as well as informing summative assessment. Another role of the Process Diary, at least as important as this, is as a reflective medium. This will support a pupil in reflecting on her/his own experiences, and through that reflection moving on to future activities more effectively and appropriately. Schön's perspective of the reflective practitioner is considered to be a very powerful one, with reflection seen here as central to design and technology practice.

Introduction

Over the last five years the pendulum of emphasis in the Design and Technology curriculum has swung increasingly from a process-centred approach to one that is product-oriented. The threat of losing the focus on experience and giving credit for a school pupil's journey towards a final product prompted us to explore the use of some kind of Process Diary. Our intention is to develop a semi-formal tool which promotes pupils' development of reflective practice and supports teachers in assessing their pupils' experiences and understanding. This is based on the use of informal Process Diaries by undergraduate students following Design and Technology Education courses and work published by a number of researchers on teaching and learning. This led us to use a spiral model of learning with a central spine of *reflection*. We have undertaken pilot studies and are currently engaged in formal, small scale research with teachers of pupils between 5 and 14 years of age. We describe our initial, very promising findings in this paper.

Background

The deliberations of the working group, set up in 1988 to explore the role of Design and Technology in the proposed National Curriculum, referred to design and technological capability with a strong emphasis on the processes experienced by school pupils and the range of contexts explored (National Curriculum Design and Technology Working Group, 1988). The view adopted was one focussing on process as much as any product, emphasising the development of transferable procedural capability through integrated reflective and active aspects, as described in the Assessment of Performance Unit's research findings (Kelly *et al*, 1987). This perspective was carried through, with little modification, to the statutory Order for Design and

Technology in the National Curriculum (Department of Education and Science, 1990). There followed the implementation of this Order in schools and, effectively, the new definition of Design and Technology, with varying degrees of success. This was paralleled with a wide ranging debate within design and technology education between educators supporting product-centred and those holding process-centred perspectives. One significant, powerful and contentious participant was the Engineering Council who reported on Design and Technology in the National Curriculum in 1992 (Smithers, A. & Robinson, P., 1992). This closely followed a report by Her Majesty's Inspectors (HMI) in a similar vein which was widely considered to have criticised the 'process view'. The pendulum rapidly swung and proposals were published for revision of the statutory Orders for Design and Technology in the National Curriculum, first from HMI (Department for Education, 1992) then the National Curriculum Council (1993). A number of organisations had seen the writing on the wall in advance of these reports and the product-centred perspective was already strongly in ascendance by this time.

Having also seen the writing on the wall we were very concerned that a view of educating for design and technological capability we subscribed to was rapidly becoming eroded. The emphasis of the statutory requirements was moving in such a way that planning and making activities were becoming paramount while evaluation and reflection were significantly side-lined. We were concerned that the experience of pupils engaged in design and technological activities should be seen as equally worthy of credit as the final product. We were also keen to develop the very successful reflection tools we were using for undergraduate education in such a way that they would support school pupils in

reflective practice. This prompted us to explore the possibility of using a Process Diary of some kind, for school pupils, as a vehicle by which they can reflect on their individual day-to-day practice in design and technology.

By using a Process Diary a record of reflections can be built up representing evidence of the journey taken by a pupil. This informs the assessment of a pupil's performance, crediting the processes undertaken or explored, evidencing reflective practice and demonstrating the understanding of the procedures followed in designing, making and evaluation. We see this as making the conflict between product and process redundant as far as both formative and summative assessments are concerned. We also see the Process Diary as leading easily into action planning for future activities as well as reflecting on past ones.

Developing a Theoretical Framework

In formalising our theoretical framework for this we referred to the work of David Kolb (1973, in Gibbs, G., 1988) on learning styles. He describes four distinct (but not necessarily exclusive) types of activities which learners engage in to varying degrees while learning. The extent to which a particular type of activity predominates depends on the learning style profile of the learner and where the activity is located within a series of related activities. Using Kolb's types, learning experiences may typically be described in terms of cycles of activity in which the learner moves between learning styles. The proficiency of the learner at this depends, according to Kolb, on her/his particular learning style profile.

The Kolb learning cycle describes learning as moving from the empirical perceptions of a concrete experience to reflective observation (*reflection*) on that experience. Here s/he internally describes what has been perceived, including her/his feelings about the experience. S/he analyses and evaluates the experience in terms of her/his own criteria. This activity is followed by the learner engaging in a stage of abstract conceptualisation in which connections are made with other personal experiences and previously held knowledge and understanding. General conclusions are drawn from the reflection in the light of these leading to specific conclusions. From these conclusions the learner formulates an action plan which leads to further active experimentation, (*experimentation*) putting what has been learnt into practice, leading to a new concrete experience and thus repeating the cycle. We were attracted to this model in general terms. It describes the kind of activities that we feel a learner engages in and fits these together in a configuration

that to some extent 'rings true'. In looking at the model and reflecting on it, it appears to us to fit in

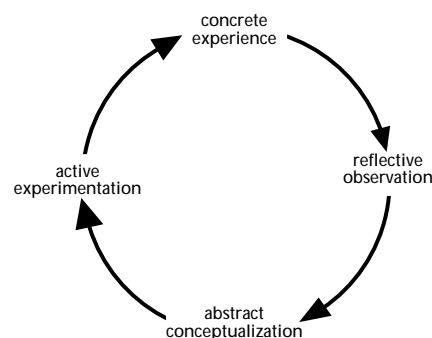


figure 1. Kolb's learning cycle

well with our individual experiences of learners (including our own learning). It agrees with a view of the learner as actively constructing and reconstructing a view of the world to which we subscribe. Our thoughts on active conceptualization do however, throw up conflicts and we are unhappy with the model in a number of ways.

We feel the model is restrictive in not accounting for such conflicts in learning. It does not allow for the occasions where new information is in conflict with existing knowledge and understanding. Where this happens, making new connections becomes difficult if not impossible. We can see a kinship between conceptualization and something like Piaget's assimilation but nothing which can be described similarly in terms of accommodation (see, for example, Boden, M.A, 1979). In addition, like many such cyclic models, we felt the repeated sequence was less flexible than it need be, denying, for example, reflection following conceptualization. Rather than being one stage in a learning cycle we see reflection as supporting cognition throughout learning, taking place between and within each element of Kolb's cycle. We propose then, a variation on Kolb's cycle.

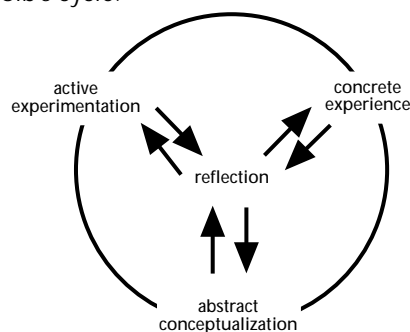


figure 2. Variation on the Kolb learning cycle

As with any model of learning this is a simplification of what are undoubtedly complex and much varied activities. We are seeking only to develop a tool to discuss learning rather than attempt to describe cognitive activities themselves. In our model, Kolb's

conceptualization follows concrete experience and leads to active experimentation. We see the reflective process as fundamental to learning and so place it at the centre of the learning cycle functionally equidistant from the other elements.

In reality it is difficult to think of reflection as separated from other learning activities at all. We are aware of the difficulties in separating active and reflective modes and do so only because of the granularity of our hypothetical model. We do feel it is informative to focus on artificially unpacked identifiable elements in this way so that they might be better addressed when seen in the repackaged holistic whole.

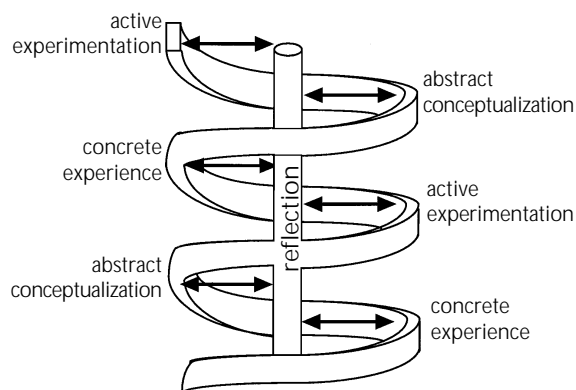


figure 3. The Spiral learning cycle

Developing the model further, and projecting the two dimensional view described into a third dimension, the flat disc becomes a spiral path around a central spine. Activities described as *experience* followed by *conceptualization* and *experimentation* lie on the spiral path with *reflection* as a spinal core around which these other elements of the learning process take place. Further we can use this model to describe the learning process as a widening spiral of conceptualisation-experimentation-experience around a spine of reflection. This reflective process is connected to each element and pathways exist connecting any one element to another. We see the spine as providing 'short-cuts' up and down the model as well as across it illustrating possible connections between past experiences, conceptualization activities and experiments, and also previous reflections.

In our model, conceptualization describes the application of cognitive processes by which the learner develops ways of organising or arranging knowledge and understanding. This is similar to Piaget's notion of schemata, through which the learner can be described as interacting with the world. These arrangements are developed through experience, namely observations and interactions s/he has experienced and which have been

incorporated in her/his memory. This will include some kind of representations of events, situations, objects and relationships. In our model we see this as open to testing or extension through experimentation. By this we mean planning for a particular, and perhaps contrived, experience and predicting the outcomes of that experience. The perceived outcomes of the experience may be compared with those predicted and the model modified accordingly through conceptualisation. We see reflection as the pathway through which these elements are accessed, or indeed jumped. In the model an element may be visited many times, once, or not at all. Fluctuations in the breath of the spiral denote the narrowing and broadening of learning with development. As completely new experiences are encountered the cycle can be seen as shorter giving a narrowing of the spiral with elements following closely as the learner 'gets to grips' with new experiences. As the learner's confidence and grasp of a domain of knowledge or understanding grows the cycle will similarly lengthen giving a broadening of the spiral.

We feel the spiral model is particularly useful in discussing the place of reflection in the learning process. It is worth, however, seeing how this model relates to some of the dominant theories of learning before proceeding. Our model reflects the notion of a learner developing cognitively on constructivist lines with active restructuring of knowledge through experience. Constructivist views describe children building and modifying their cognitive schemes of the environment. These are seen as being formed from and through experience and are used to support the child in interacting within her/his environment.

Using a spiral model prompts reference to Bruner's work, particularly his own description of the 'spiral curriculum' (see, for example, Lefrancois, G.R., 1979). Bruner's spiral describes a learner's experiences of increasing complexity, progressing through experienced situations in similar contexts that are more cognitively demanding, appropriate to their developmental locus. The model we describe would fit comfortably within this. Bruner makes it clear that he sees learning as most effective when it is guided, we see the facilitating role as most powerful within the reflection spine. Here the learner may be guided on the focus s/he takes, the type of experiment planned and observations sought, what outcomes might be important to explore, and what knowledge, understanding and experiences might be valuably reviewed or gained. S/he may require support in 'unpacking' experiences and dealing with and interpreting her/his feelings towards them. S/he may also need help in making

connections or dealing with conflicts when comparing new experiences with past ones and existing schemata. This relates to the work of Vygotsky (see, for example, Child, D., 1977) and the notion of mediation, and Feuerstein's elaboration to mediated learning experiences.

We see reflection as an essentially self-directed activity undertaken by the learner, at times with the appropriate help of a mediator. We would expect a teacher to take such a role, supporting learners in their learning about the world within a curriculum defined by the school/local authority/government. We recognise that most learning probably takes place without such support and indeed believe teachers should be aiming for the learners they work with to eventually become totally autonomous in all their learning. The less experienced the learner in a domain, the more support we would expect her/him to need. This is not only a function of cognitive development but also the type of experience being dealt with, and its familiarity; that is the range of earlier, similar experiences available to reflect upon. This all relates to the notion of metacognition described by Flavell and others, in which a learner can become consciously aware of her/his thinking when, for example, involved in design and technological activities and recognises in which s/he can monitor this learning and have better control over it. It was our intention to explore the use of process diaries then, as a tool to promote reflection and its application in future learning as well as being an assessment medium.

The Research

Our research scheme is based on including teachers in action research as partners throughout the whole process and particularly as primary data collectors. The strategy and data capture formats employed followed pilot studies undertaken in the first half of 1993 and were based on using the process diaries themselves as the main data capture media. The research required six teachers, from a range of schools, to be released for a total of two days each, to support their action research as research partners. This included half a day group induction following individual meetings which established partnership contracts. The induction included negotiation of strategies and time scales, including targets, and established programmes of support including time off-timetable. The remaining one and a half days were negotiated and included at least half a day presenting and disseminating the outcomes of the action research. The teachers evaluation reports form one set of data providing contextual details for completed pupils' Process Diaries which represent another set. Analysis of these data is expected to inform on how teachers and pupils use Process

Diaries and how effective they are in supporting learning, particularly in developing reflective practice.

Pilot studies conducted by Maggie Rogers in the Summer term of 1993 raised some interesting issues surrounding our original views. Although we had used booklets with a set format during the pilots with National Curriculum Key Stage 3 pupils these did not seem appropriate for Key Stage 2 pupils. Therefore different methods were used to record the process including photography, video tape and audio recorded interviews. Some interesting work with emergent readers/writers at Key Stage 1 also developed at that time and this influenced our choice of teachers to invite to take part in the funded project.

We therefore invited teachers to join us who were responsible for the following pupils :

School A :5 to 6 year olds in main stream education

School B : 8 to 9 year olds in main stream education

School C : 10 to 11 year olds in main stream education

School D : 11 to 16 year olds in special education

School E : 11 to 14 year olds in main stream education

School F : 11 to 14 year olds in main stream education.

This, we believed, would yield the most comprehensive initial indicators in relation to National Curriculum design and technology.

We held a meeting for the teachers early in October 1993 during which we discussed findings from the pilot studies. We also designed a layout and format which we felt would satisfy the needs of the key stage 1 and 2 pupils. This was distributed within the next week and the pupils started to use them soon after. These teachers were visited to offer varying amounts of support in terms of practical help and physical resources. The whole team met up at the end of January 1994.

Initial Findings

The initial discussion at the January meeting, at which all project participants were present, centred on time management, format of the diary, levels of delivery, the changes in the National Curriculum brought about by the wide ranging Dearing Report (1993), assessment of understanding and pupils' and students' evaluations of the diary.

Work carried out with 11 to 12 year old pupils who were being introduced to workshop skills indicated the value of recording how it felt to use the

equipment. The diary needed to support strategies for building reflection and used as a framework rather than a constraint. By using the diary the pupils seemed more aware of the process of designing and making and the value of recording it. This led to them thinking more about their experiences, achieving more and using the diary as a medium for communication with the teacher.

The other key stage 3 pupils were encouraged to work in a more personalised 'Techno-log' and address the issues of resolving problems and identifying what they wanted to achieve. The 'product/ process' debate at that school was continually being addressed. This was done by requiring the submission of the end-product of design and technological activity for assessment and also asking the pupils to keep a record of all the process they experienced. However the teacher felt this wins only half the battle. The process record produced by pupils represents only a tally of experiences in a very superficial and bland way. To be in any way a reflective tool a process diary must allow pupils to externalise their personal understanding and communicate with themselves as well as the teacher.

Spontaneity and trust were identified as crucial and bridges needed to be built for others to see the process which by its nature is a spontaneous, unedited activity. Ground rules needed to be established to include defining who is to see the diary and who is allowed to comment on it. To be effective the diary would need concentrated effort and enthusiasm on the part of the pupils and time allowed for its completion. This issue will be discussed further at a later point in this paper but we need to note that allocation of time for 'lessons' varies from class to class and across the age ranges.

Throughout the key stage 1 and key stage 2 trials it was apparent that the use of the diary, in whatever form - written, verbal, audio, video or photographic had increased motivation. The semi-formal sheets were more accessible than blank sheets or design books and although initially the pupils seemed hesitant they were generally impressed with an A3 format. Taking photographs at key stage 1 was a great motivator as the teacher would only do this if the pupils were working. When the photographs were processed the pupils were responsible for attaching them to the sheets.

During the key stage 2 trials the Year 6 pupils took their own photographs. This was a development of work carried out by Maggie during the pilot studies where the issue of selection when taking photographs arose. She questioned the role of the

teacher when recording 'evidence' since the criteria used for selection of significant stages in the process were not necessarily the same as the pupils's. This work was carried out with Year 1 and the results seem to indicate that the pupils focussed on details important to them, for instance the 'treasure' which went into the treasure chest on the pirate's galleon was recorded rather than the structure of the boat itself. The Year 6 pupils 'set up' their photographs, recording again what they regarded as significant stages in the process informed by more experience of having the process recorded.

As reflection was incorporated into the sheets of the diary with the space to relate what they had to think about, the expectation to 'think through' the problems encountered was made explicit. The Year 6 pupils used the diary quite naturally in conjunction with their practical work moving backwards and forwards between the two activities. The format of the diary sheet was critical to the success of directing thinking and provoked a great deal of discussion during meetings with the project teachers. This went across the three key stages as each teacher referenced the sheets to the curricular demands of their particular key stage. As a result of these discussions it was decided to develop two sheets - one to start the activity - the other an on-going sheet where the reflection was recorded at the beginning of the next sheet as the context for the next session. This, we hoped, would encourage the pupils to see the process as 'seamless' rather than separated by time.

Linked with both the previous sections, that is the diary as a motivator and as an aid to mediating learning and directing thinking, evidence is emerging that children are better able to articulate the problems they encounter through keeping the diary. With the Year 6 pupils, individuals were seen to move further because of the way they needed to work with the diary. Certainly the more independent Year 4 pupils recorded more despite an initial resistance to writing in the diaries. The video recordings taken of Year 1 pupils talking about their pirate galleons clearly demonstrated that their attitude to problems encountered was very positive and throughout the trials problems were seen as a challenge rather than a hindrance to the process.

Through our experiences in the use of process diaries in Higher Education we have found students are not inclined to reflect automatically in a formalised way. They can describe what they have done but they seem to find it difficult to take the next step in reflecting on what they have gained from the experience to develop their understanding of the process. This is particularly true when the

experience has not been particularly positive and yet this is when it is essential to reflect and see problems encountered in a different light - to see them as challenges to the ideas. It was for this reason that we developed the induction course for our Design Studies students.

With the Year 1 pupils the diary allowed the teacher to control the rate of the activity. It was not unusual for the pupils, in their enthusiasm for the making, to design as they made. The teacher reported that she was able to stop this happening in an unconsidered way as the pupils had to think about what they were going to do and gained a better idea of what they were likely to achieve. In the Year 6 classroom the activity was very public with diary sheets displayed at the same time as they were in use. This gave the pupils a clearer idea of where they had been and where they were going which in itself supports the management of time.

The communication between the teacher and the pupils was seen to be more effective using the diary. This was particularly true of one child with whom the teacher achieved more effective communication through the diary than had been previously experienced. This child had an identified special learning need in terms of communication and the exchange was seen as something of a breakthrough, however temporary.

One unexpected finding was linked to the confidence of one of the teachers who had recently focussed on design and technology in her teaching and had little prior experience herself. The teacher felt that helping the pupils solve their problems was an important issue. Being more than one step ahead was essential while letting the pupils see that adults do not always have all the answers. Through working out their ideas in their diaries, identifying and reflecting on the problems and sharing their ideas, the pupils gained, in effect, some independence from their teacher. Maggie worked with this group to support the design and technology skills necessary for the pupils's project and it was clear that from visit to visit tremendous 'leaps' had been made in the development of their ideas and the resulting outcomes echoed this. So despite the teacher's reservations the pupils were working independently within the normal classroom organisation. Evaluations at the end of the project revealed that the pupils were satisfied with their work and could be encouraged to set their own problems for the future.

Across the two key stages it was felt that the standards of achievement of pupils were better as a result of the process demanded by the diary, and the Year 1

pupils benefited by the more structured approach offered. The pupils's response to the spaces was predictable - they used large writing in large spaces for filling in their reflections and this was seen as an issue which has already been addressed in redesigning the layout of the sheets. The section which asked them to record what they had achieved each day was more concrete and they found it easier to use.

Teachers also reported that it was easier to build in progression and to evidence that progression with no extra work. This is a particularly important issue at the present time with teachers still reeling from National Curriculum Standard Assessment Tasks at the end of key stages and waiting to see how the Dearing recommendation will develop in practice. In the meantime they need evidence of children's achievements for the children themselves, their parents/guardians and other members of staff.

Conclusion

At the time of writing the project has another three months of trialing left during which we hope to gather more evidence from pupils's responses across the key stages. What is apparent so far and links with our background research is the effective communication achieved through using such a format for the children's learning. The questions posed by the sheets seem to direct their thinking and help them articulate their problems. The diary sheets clearly indicate when and how much effort has been put into the development of ideas; this is not possible to falsify - the pupils cannot 'catch up' as it were but can only record what they have done. In the same way, if a student misses a lecture they may copy up the notes but cannot usefully reflect on an experience they have not had!

As Gibbs (1988) points out, the detail of reflection fades within a specific time and this brings us back to the issue of time management raised earlier in this paper. Children in key stage 1 and 2 have, generally, a more flexible timetable to allow for them to work at their own pace and ability level with written communication. Children at key stage 3 with a more structured time tabled framework will need to be given time to 'fill in' their diaries, albeit in note form, so that the reflection is not lost with the sound of the bell to change class. This we hope to be able to clarify further at the end of the project when we have more evidence from our key stage 3 colleagues. Conversely key stage 2 pupils have been able to use time allotted to language work to develop their skills through the diary and research time has been gleaned from the relevant curriculum areas. At key stage 1, the work on the diaries has

also offered the pupils further opportunities and purpose to developing their writing skills.

This analysis of initial findings has focussed mainly on written communication but, as we outlined earlier, different methods used in the pilot studies to record the process were the main reason for extending our trials of the diary to cover key stage 1. Across all the key stages photography has been used with the written communication to illustrate and 'bring to life' the process. This in itself is not a new technique but could be viewed as supporting the emergent writer as well as an aid to reflection. In the pilot studies children were given their photographs to write about and their class teacher remarked on how much more most children had achieved with the photographs as a focus. Again, in the pilot studies, video tape was used to record a part of the process of a project for children with learning difficulties to help them remember, from one day to another, the experience of a visit. This has been further developed with older, key stage 3 pupils with severe learning difficulties at the special school in the project. Recording interviews on audio tape has also been very successful at key stage 1 and 2. Two of the project teachers reported on the pupils's willingness to evaluate the project in this way and the results are very impressive.

We are at the stage then, of having completed a first pass through the data collected with follow-up interviews with our research partner teachers. The research now proceeds onto using process diaries which incorporate the changes indicated, at key stage 1 and 2. The key stage 3 teacher researchers are developing a format more appropriate for adolescent pupils and incorporating a more structured assessment strategy. In special education more extensive use of video and still photography is taking place in supporting pupils' reflection. We hope to use the data from these, both pupils' completed diaries and teachers considered evaluations, to draw up guidelines for wider dissemination and application. We intend publishing case study materials from our research partners in school, whose help and invaluable support we acknowledge here. We particularly thank Fiona Bratt, Jo Djora, Jan Flavell and Liz Mazzola.

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