A Cultural Historical Activity Theory framework for understanding challenges experienced by Student-teachers of science at secondary level of education in Bangladesh

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Abstract: *This article critically reviews Cultural Historical Activity Theory (CHAT) as a framework for analysing secondary level teacher education with a particular focus on science teaching by student-teachers in Bangladesh. The review draws assumptions from CHAT that student-teachers may experience contradictory situations due to their past experience of teaching as school students and the culture of the school where they go for practice teaching. These contradictions can create challenges for student-teachers and influence their choice of teaching methods in school. Initial Teacher Education is seen here as an activity that takes place in two different cultural settings – training college for course works and partnered school for practice teaching. It is argued here that a CHAT framework can trace back the root of current issues in teaching practice to past experiences and can draw learning to negotiate the issues to change practice.*

Introduction

The premise of science education today is to facilitate students in acquiring process skills, higher order thinking and scientific attitude. High school graduates with sound scientific knowledge and skills possess significantly increased career opportunities (Ainleya & Ainleya, 2011). The education policy of the Organization for Economic Cooperation and Development also endorses participation in science as an important place for students' present and future life (OECD, 2006). In a developing country like Bangladesh, science stream was once a popular choice of study because of high likelihood of better job opportunities and social and economic status enjoyed by professionals working in science related jobs. However, during the last two decades student enrolment in science has declined by 48% (Karim, 2012). Although science is compulsory up to secondary level, it seems that science education is failing to attract students for further and higher education. Secondary graduates are opting more for non-science disciplines for higher secondary and higher education. Among various reasons, lack of quality teaching in secondary schools has been considered as an important factor (Choudhury, 2009) for this declining state of science education at different levels. The prevalent transmission model of teaching, with its emphasis on low-order thinking skills, has been identified as one of the major factors for low achievement in secondary science (B.Ed Curriculum, 2007).

The national secondary curriculum in Bangladesh aims at developing students' scientific knowledge, skills and attitudes; considering the global and national job market and the rapid development of science and technology. Texts, learning materials, teacher training, supervision and various other interventions are developed to some extent in order to provide a more practical approach to teaching science at secondary level. The secondary level initial teacher education (ITE) curriculum has also been updated in 2007 to bring about change in traditional teaching practices. Secondary level ITE in Bangladesh is carried out by teachers' training colleges around the country. Student-teachers or teaching candidates enrol with the view of earning a one-year Bachelor of Education (B.Ed) degree which certifies them qualified for teaching in secondary schools. During this one-year period student-teachers go through course works, micro-teaching, simulations and actual teaching-practice in partnered secondary schools. The revised B.Ed curriculum includes constructivist learning theory and teaching approaches with the aim of improving the preparation of teachers and changing the teaching approaches in schools.

Despite the change in ITE curriculum, significant change in the methods of science teaching has not been observed (Tapan, 2010); teachers are still using a traditional transmission model for teaching science. There may be numerous reasons for why teachers are not taking up or using constructivist teaching approaches in this classroom. However; I have directed my focus on the challenges that student-teachers may experience while using constructivist approaches during their teaching-practice stage. Student-teachers play the roles of both students and teachers and they come into ITE with their personal, cultural, historical background. Student-teachers' situation is better understood through Head's (1992) comment:

> *They are no longer just students, nor are they fully teachers; rather, they are student teachers on the threshold of their careers as professional educators.*

In this review I intend to discuss the potential and appropriateness of Cultural Historical activity theory (CHAT) as an analytical framework to investigate the challenges experienced by student-teachers, and to identify ways in which they can be supported. I will provide a brief account of constructivist teaching approach and the potential challenges of applying this approach, then present a discussion on the basics of CHAT and how it can provide a framework for analysing and understanding the mentioned issue.

Constructivist teaching approach

The constructivist approach to teaching is based on a combination of particular strands of cognitive and socio-cultural psychology widely known as constructivism. Constructivism is a theory of learning rather than a theory of instruction (Haney & McArthur, 2002). The principles of constructivism can be considered as frameworks for developing teaching approaches where learning is seen as individually constructed understanding of nature, which is informed by an individual's prior learning, experience and knowledge. Individuals create their own learning based on the interaction between what they already know and what is presented to them (Richardson, 1997). The role of a teacher in constructivist approach is quite different from that of a traditional transmission approach. In a traditional approach the teacher mostly lectures lesson contents and learners play the role of passive recipients. On the other hand in a constructivist approach teacher plays a facilitating role and students actively participate in learning. In this regard a science teacher's role is to mediate scientific knowledge to learners and help them to make personal understandings of how scientific knowledge claims are developed and tested (Driver et al., 2004).

There are various challenges in applying constructivist teaching approach in the classroom. One of the challenges can come from teachers' beliefs and experiences that shape their identity as teachers. The dominant approach to instruction is didactic where established facts and procedures are transmitted from an expert (the teacher) to the novices (the students) (Snowman & Biehler, 2006). On the other hand, constructivist theory places higher authority on students in the learning process. Each student creates personal meaning of the information provided, through collaboration and discourse with others. Students' New learning develops through the filter of their existing learning and experience. The teacher's role in this type of learning process changes from someone providing all the information and answers to someone creating opportunities for students to construct meaning. The challenge can arise from the tension between teachers' belief and experiences about teaching and the constructivist demand of teachers' role as facilitators. Beliefs are rooted in memories of experiences (Haney & McArthur, 2002). The influence of personal experience is reflected in Duffy & Atkinson's (2001) comment that teachers tend to teach as they were taught rather than as they were taught to teach.

Another challenge can come from school culture; which produces rules, norms and expectations about teaching and learning in the classroom. In this regard the concept of culture is about a group's shared beliefs, customs and behaviour. Windschitl (2002) states in this matter:

> *The day-to-day routines that unfold in classrooms are always situated in a larger context - a tacitly understood framework of norms, expectations, and values that give meaning to all activities occurring in schools*

School culture includes the obvious elements of schedules, curriculum, policies and the social interactions that take place in the institution. Cultural challenge portrays the implicit norms and expectations that govern behaviour of teachers and students in the classroom.

Teaching from a constructivist perspective can be time consuming and places higher demand on students' participation (Snowman & Biehler, 2006). The challenge comes from the theory's emphasis on students' active participation in knowledge production and their greater authority in the learning process. Teachers can face issues in using a constructivist approach to teaching if the school curriculum, plan and policies put greater emphasis on students' exam results and promote a conventional teacher-centred approach. The issues that are challenging for regular teachers to negotiate can be far more challenging for student-teachers; they are being asked to enact practices that they have not experienced in a situation in which they are considered to be a novice.

Cultural Historical Activity Theory

In activity theory, the unit of analysis is the activity itself and it takes into consideration the social and cultural setting in which human activity is situated. Vygotsky, Luria and Leont'ev developed the idea of artefact-mediated and object-oriented activity. Activity is seen as an interaction between a 'subject' and 'object' through mediating artifacts or tools. The interaction is goal or object-oriented. The 'subject' in activity refers to human actors who work towards a desired goal. The object serves as both material entity (something to work on) and the embodiment of vision, idea or purpose (Williams et al., 2007). The notion of mediating artifacts or tools refers to physical instruments (such as computer hardware, equipment), conceptual schemes (such as mind map, work plan, strategies) and language tools (i.e.; text, language, mnemonic). Tools which are culturally specific can also direct people's thoughts and actions (Jonassen & Murphy, 1999). Activity is a process where mutual transformation between subject and object is accomplished. Activity Theory has evolved through three generations of research originating from Vygotsky's work on artefact mediated activity (Engeström, 2001).

First generation

Triangular representation of Vygotsky's concepts of human activity and mediation has been considered as the first generation of activity theory (Daniels 2001). Mediation refers to development or change of behaviour through the use of artifacts or tools. The model represents the interaction of mediating artifacts with human actions to render the outcome or objective. In this approach to activity theory, the individual is the focus of attention.

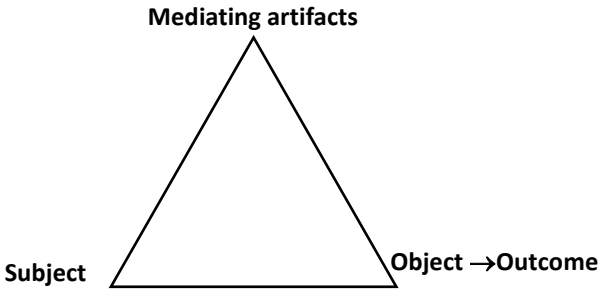

Figure 1. First generation of activity theory

Engeström (1999) explains this activity model through the example of himself preparing and giving a speech at a congress where the speaker is subject of activity. The subject prepares and gives a speech through the use of literature, written and spoken text. His object of preparation is the central issue of activity theory and the object or purpose of speech is to develop consciousness about the issues among the participants. These rendered the outcome of text for the speech and later debate and reflection in the conference.

Leont'ev (1978) suggests the hierarchical nature of activity where the main activity is at the topmost level and it is directed by the object or motive. Actions are short-lived and have definite starts and ends and the same action can serve different activities. Mid-level actions are directed to achieve certain goals during the process of the main activity. And the lowest level operations are originated from certain motivating conditions occurring during the activity. In a teacher education programme an individual student-teacher or a teaching candidate is the subject of the main activity with an overarching motive or object of becoming fully a certified teacher. Driven by this motivation the subject performs mid-level actions such as doing course works with the goal of passing the exam or achieving good grades. While doing the course works s/he performs certain operations like studying, literature search; which are directed by certain conditions originating from the requirements of the course work. Subject or the student-teacher uses different kinds of tools like text materials, lesson plans, lectures to pursue the ultimate object of being a teacher.

Second generation

Engeström (1987) expands the original triangular model of first generation activity theory to incorporate social and collective elements. Engeström (1999) points out certain limitations of the first generation activity model that it does not expound the social and collaborative nature of activity and also does not elaborate on the actions. The action seems to be 'limited and situation bound' (Engeström, 1999).

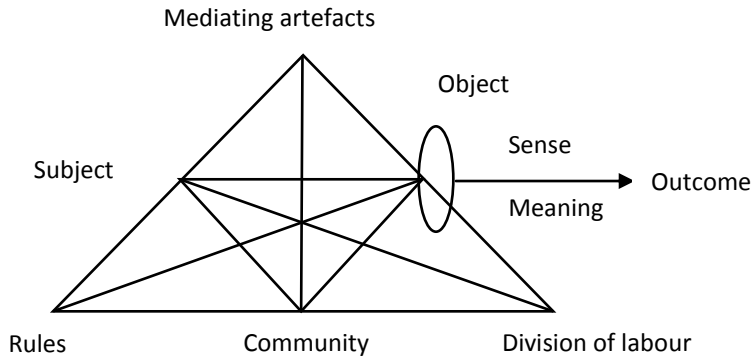

Figure 2. The structure of human activity system (Engeström, 1987)

The second generation model enables wider examination of activity systems within a social or collective structure. The subject no longer remains an individual but is placed within a

group, which interacts with the object through the mediating artefacts. An individual's actions are directed to the collective object/motive of the larger activity (Engeström, 1999). The second generation activity theory emphasises analysing the interactions among community, rules and division of labour and their influence on the activity system. The interactions among different poles of activity are represented by the connecting lines in the activity triangle (Figure 2). The community refers to groups of individuals/sub-group who share the same object and the division of labour refers to both the division of tasks among the members of the community and the division of power and status. The oval shape indicates the object-oriented actions, which are characterised by ambiguity, surprise, and interpretation among the subject group, sense making and possibilities to change. This approach to activity encompasses individual subject/s and his/her/their interaction with the community and context. In a teacher education activity subjects or student-teachers become part of a larger group of other teaching candidates. There is also a larger community that comprises of student-teachers, lecturers and administrative stuffs of the college who have particular roles and responsibilities (division of labour) to perform. They are directed by certain curricular guidance and regulations in the college.

Third generation

In real life an activity system does not stand in a vacuum. It stands within a network of other activities and interacts with these systems. Engeström (2001) considers standaloneness of second generation activity theory as a challenge for analysing diversity, multiple perspectives and interactions. He proposes that the third generation of activity theory needs to develop tools to understand interaction, multiple perspectives and networks of interacting activity systems. Engeström considers joint activity as a unit of analysis which takes into account the social settings of the activity along with conflicting practices (Daniels, 2001). In a network of activity, contradictions and struggles take place in defining the motives and objects of an activity. It requires the analysis of power and control within activity system.

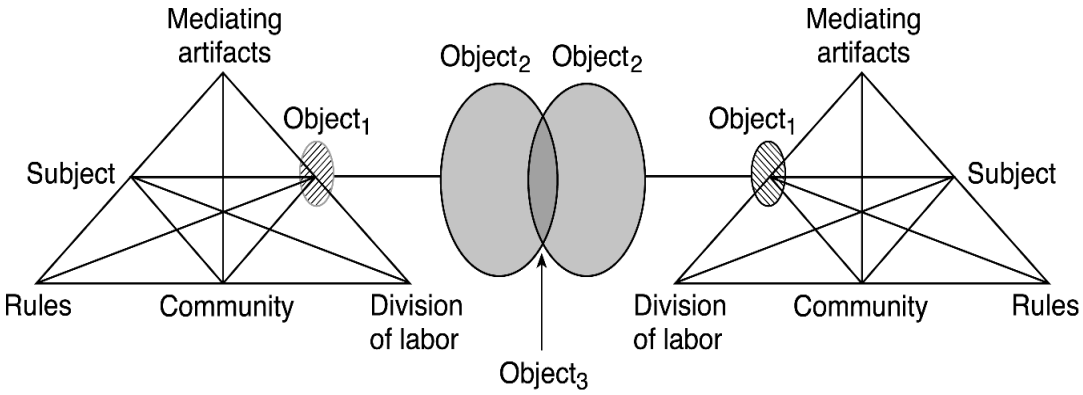

Figure 3. Two interacting activity systems as a minimal model for third generation of activity theory (Engeström, 2001, p.136)

The object in this version of activity theory (Engeström, 2001) moves from the initial individual stage (Object 1) to a wider and collectively constructed state (Object 2) while interacting with a neighbouring activity system. It then evolves to a collaboratively constructed object. This indicates the dynamic nature of the object in joint activity. As an activity system works in interaction with networks of other activity system it receives rules and instruments from other activity systems (like the management system in a factory). Within the context of a teacher education programme the central activity system receives policy and curriculum guidelines (such as constructivism and constructivist teaching approaches) from government agencies and when student-teachers go for practice teaching in the partnered schools they interact with the activity system of that institution.

A CHAT framework

The underlying concepts of activity theory emphasize exploring the object of activity which in this review is student-teachers' object of becoming professional educators. Exploring the object provides understanding of both the nature of activity and the motives driving it (Kaptelinin, 2005). One activity can be distinguished from another through the analysis of the object (Leont'ev, 1978). Activities are object or goal oriented social practices (Engeström, 1999) and a CHAT framework allows exploring the objects of a social practice like teacher education in its social context. Analysis through activity theory enables investigation of the generative forces (student-teachers' experience as students and school culture) that develop student-teachers' beliefs and ideas about teaching and learning. Moreover, it allows exploration of the identities of the subjects (the student-teachers) in the activity. The acting subjects (the student-teachers) may draw on their repertoire of identities in adopting a position in relation to an activity (Williams et al., 2007) which in this case is the activity of becoming teachers. Student-teachers play the roles of both students (in Teachers' Training College) and trainee-teachers (in schools) during the teaching-practice. Their object/goal is to assume the roles and responsibilities of a teacher. Their object of becoming teachers interacts with two distinctive activity systems: first, with that of the Teachers' Training College and second, with the partnered school system. In both systems different kinds of tools or mediating artifacts (lectures, course materials, and practice of teaching) are used for different divisions of labour (roles of training college lecturers, student-teachers, students and teachers in partnered school). These two activity systems also have different communities involved with their activities such as administrative and academic committees, government agencies that provide rules, regulations and curricular guidance for the training college and the partnered school. In a CHAT framework all this elements are analysed to understand the central activity.

An important aspect of a CHAT framework is the embodiment of contradictions in activity systems, which work as change agents in activities. The potential of contradictions has been utilized by Engeström (1987) in his thesis of *Learning by expanding*. Engeström (2001) posits contradictions as the sources of change and development. Contradictions are the structural tensions within and between activity systems. Contradictions occur within each component (subject, object, rules, community, and division of labour) of the activity system (Engeström, 1987). Contradictions arise from the stiff hierarchical division of labour, which prevents the possibilities opened by advanced tools or instruments. Contradictions take place between the object (motive) of the central activity (the activity in practice) and the object of any advanced activity introduced to the system. Contradictions also occur between the central activity and any other neighbouring activities.

Contradictions and Teacher education

Activity theory assumes that human development—in this case student-teachers' construction of teaching identity—'functions' within social settings (which here are the Teachers' Training College, schools) whose values embody the settings' cultural histories (Smagorinsky et al., 2004). Coexisting activity systems give rise to the possibility of 'incompatible' objects or goals (Grossman et al., 1999) to negotiate. Subjects' (here the student-teachers) identity is in continuous transformation and they act to change the meditational tools (teaching strategies) to achieve their goals or object (Wells, 2004). In pursuit of their goal of being teachers, student-teachers work within a networked of activity systems with different objects, rules, division of labour and communities. The activity of initial teacher education sits within a network of activity systems like government agencies, curriculum authority and the partnered school where teaching practice takes place. Each of these systems has its own rules, community, division of labour and objects. This network may not be stable or harmonious. It can be described by contradictions caused by tensions

among the elements of central activity (initial teacher education) and from other activities around.

Student-teachers' experience as students and the dominant teaching practice may help them to develop an identity as a teacher. The foundation of identity is the interaction between inheritance and experience (Wells, 2004). They themselves were once a part of an activity system where teaching is seen as transmission of knowledge and information. Moreover identity is in part mediated by the object/motive of the activity and a person's identity is situated in the cultural context (Roth, 2004). These views on identity and its relation to object provide an important assumption that student-teachers enter ITE programmes with predispositions about teaching profession; and these predispositions help them to objectify (Object 1 in Figure 3) their envisioned teaching identity and carry on working towards that object. Their envisioned identity of a teacher (conventional role as expert) may be different and sometimes contradictory with the proposed identity of a teacher as facilitator of learning in a constructivist approach. Their object of being teachers may be transformed to a changed object (Object 2 in Figure 3) as objects of activity are dynamic rather than static in nature (Engeström, 2001). On the other hand the school's object of developing students' learning may also go through transformation due to the interactions among rules, regulations, curricular demand and expectations from the school community. This transformed object (Object 2 in Figure 3) interacts with student-teachers transformed object (Object 2 in Figure 3) when they go for practice teaching. Interaction between these two objects may give rise to a different kind of object (Object 3 in Figure 3) resulting in the development of new mediating artifacts or tools.

The CHAT methodology

Engeström has developed the CHAT informed interventionist methodology widely known as Developmental Work Research (DWR). DWR is termed by Ellis (2011) as a 'test bench' of activity theory which has the potential of both understanding the activity in question and changing practice.

DWR provides a process to represent data using the elements of activity theory (subject, object, rules, division of labour, community). This framework enables participants to understand the current practice evolving from previous practices as well as to explore and analyze tensions and contradictions for developing and improving practice (Leadbetter et al., 2007). The assumption behind a DWR approach is that development occurs through the 'emergence', 'transformation' and solution of contradictions in activity systems (Virkkunen & Kuutti, 2000). This process of transformation and development has been explained in Engeström's concept of 'Expansive learning'. Expansive learning is the process of negotiating internal contradictions in activity systems through development and implementation of new and improved processes of work (Engeström 2007a). Engeström's developmental work research occurs in participatory data analysis workshops, which are used as platforms for identifying and negotiating contradictions for changing practice. These workshops are termed as 'Change laboratories'.

Engeström (2007b) describes the change laboratory (Figure 4) as a 3x3 set of surfaces representing work activity. The setup has both horizontal and vertical dimensions and participants conceptually explore work situations from past experience to better solutions in future. Proceedings in the change laboratory start from the mirror (Engeström, 2007b). The *practitioners* face the laboratory surface and each other. One of the *practitioners* is appointed as scribe who takes notes of discussions. The *researcher-interventionist* facilitate the laboratory sessions. The *video projector* works as a display device for presenting work situations. The laboratory sessions are videotaped for data collection and analysis purposes. This also helps to review laboratory events in following sessions. There is also an archive present in the laboratory setup for the *participants* to use relevant information for analyzing and developing practice. The *mirror* surface in the horizontal dimension of change laboratory

presents work situations and is used to analyze experiences, problems and disturbances and innovative solutions. On the other end of the setup the *model/vision* surface holds place for tools and conceptual analysis. The triangular representation of activity theory is used to analyze the work activity in question. The middle surface in change laboratory setup is used for *ideas and tools* generated from analysis of work situation presented in the *mirror* and *model* surfaces. An important aspect of Change laboratory setup is that it has both horizontal and vertical dimensions. The horizontal dimension depicts participants' movement among *mirror*, *model/vision* and *ideas and tools* surfaces. Whereas the vertical dimension represents the movement among past, present and future work practices.

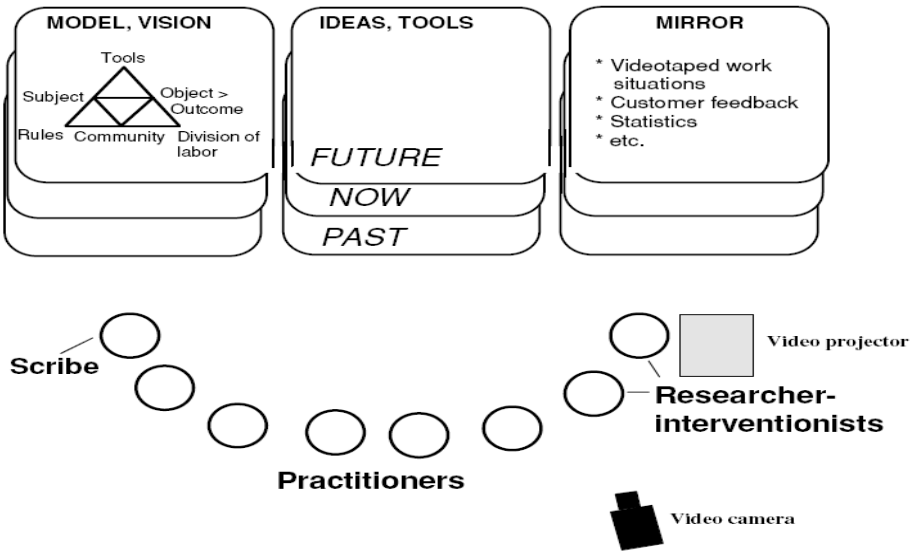

Figure 4. Prototypical layout of change laboratory (Engeström, 2007b)

Developmental work research in change laboratories has been used in different work situations and there are evidences of its potential in transforming work practice for improved outcome. There are instances of its usefulness in teacher education research also (Ellis, 2011). A CHAT informed methodology focuses on learning as a 'social phenomenon' occurring in a context that has been evolved 'culturally and historically' (Douglas, 2011). The social setting in educational institution (e.g. Teachers' Training College, Secondary Schools etc.) consists of different elements influencing the activities undertaken and teachers ('subjects' in CHAT term) come with their own view about teaching although all of them work for the common purposes of being a teacher and developing students' learning. A CHAT based analysis of these elements can offer an understanding of the interactions and potential tensions among different subjects and settings. However, more research is needed to contextualize the CHAT informed methodology in teacher education because every work situation comes with its own characteristics and historicity. Although CHAT provides a way of looking into work practice from socio-cultural perspective, what it does not offers is a prescriptive tool (Engeström, 1993). Engeström (1993) suggests three principles while conducting research using a CHAT based methodology – collective activity system as unit of analysis, search for contradictions as driving force for innovation and historical development the activity under research. In the context of teacher education these translate as looking into Teachers' Training Colleges, partnered schools, government agencies and other concerned communities, in order to understand the disturbances that can potentially hinder new ways of teaching. It is also necessary to explore the historical and cultural development of existing teaching practices as these can also provide significant challenges.

Conclusion

There are different issues that can hinder the use of constructivist teaching approaches, and among these, student-teachers' experience as school students and their predisposition about teaching can present significant challenges. Researching these challenges requires an analytical framework which can offer interpretations and explanations arising from student-teachers' past experience and their interaction with the teachers' training college and partnered school. A CHAT framework provides such an analytical tool which can explore the contradictions that can create challenge. Exploring teacher education through a CHAT framework can offer understanding of student-teachers' transformation of objects at different stages. This type of analysis can surface the contradictions or challenges in applying constructivist teaching approaches in science classrooms. Once these have been identified it is possible to intervene for change in the desired direction.

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