**Table S3: Definitions and applications of learning and social science theories used in articles included in scoping review of use of theory in quality improvement and patient safety (QIPS) education**

**Learning theories**

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| **Theoretical category** | **Theories used in scoping review papers** | **Application to QIPS education** |
| **Cognitive learning theories**  Concerned with processes such as perception, insight and meaning. Theories range in their focus on individual learners to the interactions between learners and their environments [1,2]. | **Spaced education theory**  Information presented and repeated over spaced intervals in time increases knowledge, uptake and retention [3].  **Team competition**  A social competition dynamic affects reward-processing neural systems which can have positive and negative effects on engagement and motivation [4].  **Testing effect**  Retention and retrieval of information is increased through learners being tested on content [5]. | Design of spaced online education programs where learners are emailed a scenario and multiple-choice question, receive feedback, and then are sent the same question again at a set timeline depending on response, with question being retired after a set number of correct responses [6-8].  Scales et al. [7] combined spaced online education program with team competition.  Shaikh et al. [8]combined spaced online education program with testing effect. |
| **Transfer**  Training that focuses on the fundamental concepts that underpin a skilled process can be effective in promoting transfer of that learning into new contexts, which potentially differ in their outfacing characteristics [9,10]. | Design of a course aimed to increase students’ knowledge of QI in the context of their own education with the aim of them being able to transfer their knowledge to solve problems in the unfamiliar context of the health system [11]. |
| **Theory of intrinsic motivation**  An internal force or curiosity that pushes an individual to learn about a particular topic. Learning new knowledge in the context of problems that are meaningful to the learner enhances interest and may foster retrievability and use of knowledge when needed to solve similar problems [12]. | Study of a curriculum using a problem-solving methodology. Involved teaching in relation to quality problems learners identified from their own work environments [13]. |
| **Theory of attitude-relevant knowledge**  Under high deliberation conditions, people consider the behavioural relevance and dimensional complexity of knowledge underlying their attitudes before deciding to act on them [14]. | Study of an e-learning course on patient safety to examine whether it can trigger changes in attitude, if the e-learning enables learners to gain specific knowledge and helps them to perceive this knowledge as attitude-relevant [15]. |
| **Reflective learning theory (several definitions):**  **“**Reflection for action” is the prospective mental practice of thinking ahead to identify knowledge and/or experience deficits, concerns and anxieties related to performance. “Reflection in action” is thinking on your feet to focus on real-time analysis. “Reflection on action” is retrospective thinking back on actions [16,17].  Reflection as the thinking over of ideas that have been learned, reorganizing them, and considering how they will fit into workplace patterns to improve practice [18]. | Design of communication activities for staff nurses to facilitate nursing students’ reflection about safety and quality during clinical shifts [19].  Design of a course that included medical students’ reflection on patient safety based on their own experiences [20].  Design of a course that included medical students conducting a clinical audit and reflecting on the process of the audit and reactions to results of the audit [21]. |
| **Self-regulated learning**  Self-regulated learning requires a learner to regulate three layers: a) the choice of cognitive strategies; b) the use of metacognitive knowledge and skills to direct one’s learning and c) the choice of goals and resources deployed for learning [22]. | Study of the influence of critical thinking, self-regulated learning and system usability on the acceptance of e-learning on patient safety [23]. |
| **Kolb’s experiential learning theory**  Kolb’s theory posits that learning occurs when knowledge is created through the transformation of experience. The experiential process involves a four-stage learning cycle (concrete experience, reflective observation, abstract conceptualization, active experimentation) and is affected by the “learning style” (diverging, assimilating, converging, accommodating) through which individual learners engage with material [24]. | Design of a course to develop organizational leaders who can lead and conduct improvement projects. Designed to accommodate all four of Kolb’s learning styles through inclusion of a variety of learning experiences [25]. |
| **Sociocultural learning theories**  Learning is a social process inseparable from the context in which it occurs; learning occurs through dynamic interactions between the individual and the social relations and activities occurring in the learning environment [26]. | **Eraut’s theory of formal and informal learning**  Formal learning is deliberate or organized learning often with dedicated time, presence of a teacher and/or specified outcomes. In contrast, informal learning consists of learning from other people and/or experiences; this type of learning can be implicit, unintended or opportunistic [27,28]. | Study of the formal and informal ways preregistration students in medicine, nursing, pharmacy and physiotherapy learn about patient safety [29]. |
| **Senninger’s theory of learning**  Three distinct zones for learning: comfort zone which is largely familiar and where people do not change or learn, a discomfort zone where people feel uncertainty and are most likely to learn, and the panic zone where people are too fearful to learn or change [30]. | Study of nursing students’ experience planning a QI project and their zones for learning in testing aspects of the project in clinical practice [31]. |
| **Lave and Wenger’s community of practice**  Novices begin at the periphery of a community by observing and performing basic tasks, and overtime become more central in the community. Through participation, active engagement and assuming increasing responsibility, the individual acquires the roles, skills, norms and values of the community. Learners’ participation in turn transforms the community [26,32]. | Design of a course that involved medical students situated in the clinical environment and engaging learner as an active and collaborative member of the clinical community through performance of a clinical audit [21]. |
| **Transformative learning theories**  Learning that changes the way that learners see the world; it occurs as a result of an experience that encourages reflection, typically challenging preconceived understandings and enabling positive future action [33]. | **Mezirow’s theory of transformative learning**  The process of effecting change in a learner’s frame of reference. Frames of reference refer to associations, concepts, values, feelings and conditioned responses acquired over time that define a person’s worldview and shape expectations, perceptions, cognition and feelings [34]. | Study of medical students’ use of reflective thinking, a process that contributes to transformative learning, in patient safety learning in simulation and ward based patient safety activities showed evidence of both reflection and critical reflection; critical reflection was associated with future intentions [35].  Design of curriculum for junior doctors, that also drew on theories of empathy and moral development, that consisted of reflecting on patient stories and their own experiences, to influence their beliefs, attitudes and intention of future behaviour [36].  Study of students’ QI reports and other documents produced during involvement in QI projects to identify whether project work could lead to transformative learning through action and reflection on actions that challenge current worldviews [37].  Study of the influence of critical thinking, self-regulated learning and system usability on the acceptance of e-learning on patient safety [23].  Study of the influence of a Master’s program on micro, meso and macro levels, which drew upon Mezirow’s transformative theory to explain changes at the personal level that were not the original purpose of the study [38]. |
| **Sandars’ critical reflection**  Awareness of one’s own thinking that occurs before, during, and after situations with the aim of developing a greater understanding of one’s self and the situation, to inform future similar situations [39]. | Study of the role of reflection on personal practice to identify how QI methodologies can effect change [40].  Study of associations between resident doctors’ reflection on QI opportunities and quality of their QI project proposals [41]. |
| **Organizational learning theories**  Concerned with how knowledge is created and used within the organization | **Psychological safety**  Psychological safety promotes a safe space for interpersonal risk taking and organizational learning [42]. | Design of an educational program using psychological safety frameworks to develop patient-centered medical error disclosure skills for clinicians and support patients/families to speak up about concerns [43]. |

**Social science theories**

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| **Social science field** | **Theories used in scoping review papers** | **Application to QIPS education** |
| **Psychology**  The scientific study of mind and behaviour | **Theory of planned behaviour**  Intentions to perform behaviours can be predicted with high accuracy based on an individual’s attitude towards the behaviour, subjective norms, and the perceived behavioural control (ability to control any given behavior). An individual’s intent to perform a behavior is dependent on whether they believe they can be successful [44]. | Study of intentions and actions to improve patient safety following participation in patient safety education courses for residents [45] and specialty registrars [46].  Study to identify the mechanisms that medical students use to learn about patient safety. Questionnaire used to examine personal attitudes, safety in the workplace, personal influence and future intentions [35].  Study used theory of planned behavior to analyze questionnaire and focus group data regarding transfer of patient safety concepts into practice by reported changes in students’ awareness, behavioural intentions and behaviour [20]. |
| **Theory of behavioural psychology**  For a behaviour to take place, the underlying beliefs (e.g. self efficacy beliefs, outcome beliefs), facilitators (e.g. training, knowledge and skills) and external barriers (e.g. lack of organizational opportunities) should be addressed to facilitate the intended behaviour [47].  **Self-determination theory**  Study of human motivation and personality that views autonomy, competence and relatedness as three needs that affect motivation [48]. | Design of a program for residents based on theory of behavioural psychology and self- determination theory; program aimed to enhance control beliefs (e.g. feasible QI activities within control), autonomy (e.g. bottom-up contributions) and relatedness (e.g. focus on QI as a group effort) in small-scale QI activities [49]. |
| **Self-efficacy theory**  A measure of an individual’s confidence in his/her ability to perform a specific task or behaviour and reach a successful outcome [50]. | Study of the impact of a patient safety laboratory session on recognition, resolution, and prevention of medication errors on students’ self-efficacy, measured through surveys of knowledge regarding medication error prevention and confidence in preventing and resolving errors [51]. |
| **Activity theory**  Considers the entire system in which something (such as knowledge acquisition) occurs. This includes the set of interactions, people, tools and rules that exist within complex systems [52]. | Study of how medical students learn about patient safety in the workplace found that they are part of two activity systems with existing contradictions; one focused on learning to be a doctor and the other focused on delivering safe patient care [53]. |
| **Sociology**  The study of human social relationships and institutions. Particularly how human actions and thoughts shape and are shaped by surrounding cultural and social structures. | **Bourdieu’s theoretical concepts of field, habitus and capital**  The concept of “field” describes an arena in which players produce, circulate, and acquire resources that relate to a specific area. These resources, otherwise known as ‘capital’, have different forms. Capital is field specific and confers legitimacy to those who possess more of it. The concept of “habitus” refers to why individuals from a specific group in a given field tend to have predictable patterns of behaviour that are shaped by past experiences and tend to influence future behaviours [54].  **Sociology of professions: professional socialization, hierarchy and boundaries**  Professional socialization: a process characterized by the acquisition of new knowledge and skills along with an altered sense of self, that results in learners coming to think, act and feel like a healthcare professional [55,56].  Professional hierarchy: hierarchy in healthcare has been described as playing out through an occupational and sexual division of labour. Medicine has historically occupied a dominant position in the healthcare division of labour although over time over time there has been tremendous variability and fluidity of boundaries across and within professional groups [57,58].  Professional boundaries: a professional group’s existence occurs in relation to the creation of boundaries with other groups. These boundaries are not static and professionals engage in ongoing activity to maintain, negotiate and expand the boundaries that define their group’s domains of activity [59,60]. | Design of faculty development program that incorporated incentives for faculty participation. This was based on findings from a study that examined how quality improvement is legitimized by different forms of capital in the academic and healthcare delivery fields [61].    Study of interprofessional and multiprofessional processes of three QI education programs using sociology of professions theory with particular attention to professional socialization, hierarchies and boundaries in QI [62]. |
| **Philosophy**  The study of the fundamental nature of knowledge, reality and existence | **Realist evaluation**  Aims to identify what works, for whom and in what circumstances using the formula of Context + Mechanism = Outcome. Mechanisms are often hidden and are sensitive to differences in context. Mechanisms are identified through cyclical investigations involving the examination of patterns and development of plausible theories [63,64]. | Study of mechanisms involved in patient safety learning in a cohort over a 5-year medical school curriculum [35].  Study of factors that contributed to residents’ engagement in QI work, and the educational and care delivery system design factors that facilitated and inhibited the integration of a QI curriculum into the routine work of inpatient resident teams [65]. |

\*Articles are cited more than once in instances where more than one type of theory was used.

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