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REVIEW

# The Definition, Assessment, and Mitigation of State Boredom Within Educational Settings: A Comprehensive Review

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**Abstract** Mitigating the situational factors that give rise to state boredom is a consistent challenge facing educators. Despite the growing amount of literature devoted to the construct, the field has yet to arrive at a consensus regarding a clear theoretical or operational definition. Subsequently, inconsistencies exist in the assessment methodologies, research findings lack generalizability, and strategies for mitigation in educational settings remain elusive. In this cross-disciplinary analysis, the extant literature on state boredom is critically reviewed and synthesized, and a two-dimensional definition of state boredom as an unpleasant (subjective), low-arousal (objective) experience is proposed. Findings from the technological advances of the last decade that allow for the objective measurement of physiological states are used to inform recommendations for empirically sound assessment methodologies. Finally, the proposed definition of state boredom and related assessment strategies are discussed with respect to implications for enhancing educational practices.

**Keywords** Boredom · Learning · Assessment · Definition

Emotions are of critical importance for cognitive development and optimal learning (Linnenbrink-Garcia and Pekrun 2011; Schultz and Pekrun 2007). However, not all emotions are equally relevant to academic achievement. In fact, research has suggested that "basic" emotions (anger, sadness, fear, disgust, happiness, and surprise; Ekman 1992) are rarely experienced during learning sessions (Craig *et al*. 2008; Lehman *et al*. 2008a, b). Consequently, researchers have recently begun to distinguish between "basic" and "academic" emotions (Pekrun 2011). Academic emotions refer specifically to those that

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are directly related to learning outcomes (e.g., anxiety or boredom; Pekrun 2011). Other than the substantial amount of literature examining test anxiety (Zeidner 2007), little research has specifically targeted other emotions critical to learning (D'Mello and Calvo 2011). For instance, very few studies exist studying boredom within academic settings (Pekrun *et al*. 2010), despite its prevalence across a myriad of learning environments (Baker *et al*. 2010) and its negative impact on learning (Craig *et al*. 2004; Forbes-Riley *et al*. 2011) and motivation (Pekrun *et al*. 2002; Pekrun 2010).

In response to the paucity of research on boredom and learning, the current review takes a multidisciplinary approach toward developing a deeper understanding of the construct of boredom in order to consider ways in which states of boredom can be effectively assessed and mitigated within educational settings. Before specific recommendations can be made for educators, however, an operational definition of the term needs to be established (Belton and Priyadharshini 2007). Therefore, this review surveys literature from the areas of cognitive science, psychology, and education to develop a comprehensive definition of boredom and identify potential assessment approaches. Based on this more complete definition, specific assessment and mitigation strategies are recommended to researchers and educators for application within educational contexts.

## Boredom and Learning

Boredom has long been a significant problem in education (Craig *et al*. 2004). Broadly defined as temporary feelings of low-arousal and unpleasant emotions induced by environmental factors (e.g., Mikulas and Vodanovich 1993) or individual differences (e.g., Farmer and Sundberg 1986), boredom is experienced by as many as two thirds of high school students (Just *et al*. 1991; Cothran and Dennis 2000) and has been associated with school dropout rates (Maroldo 1986). Not surprisingly, boredom can serve as a motivational barrier and be a detriment to academic learning (Pekrun 1992; Pekrun *et al*. 2002). However, compared with trait boredom, which refers to an individual's propensity to experience feelings of disinterest (e.g., Farmer and Sundberg 1986), state boredom is more amenable to environmentally based mitigation strategies. As such, the development of methods to target and alleviate state boredom has the potential to be of considerable value to educators and may ultimately improve student performance (Belton and Priyadharshini 2007).

In the past three decades, there has been a growing interest in the prediction of state boredom in the classroom. A myriad of situational factors that increase susceptibility to state boredom in educational settings have been identified, including the perception of a task as meaningless; engagement in activities that are abstract, repetitive, or devoid of excitement; a lack of direction or adequate resources; confinement to restrictive circumstances; inappropriate difficulty level of given work; a lack of momentum or flow; and having little power or control during the learning process (Brissett and Snow 1993; Chen 1998; Condry 1978; Cullingford 2002; Darden and Marks 1999; Moneta and Csizentmihalvi 1996; Pekrun *et al*. 2010; Reid 1986; Smelser 1989; Woods 1990). In a recent review of the literature, Belton and Prihadharshini (2007) concluded that mitigating boredom in education necessitates the creation of an environment that encourages student autonomy and control while at the same time is challenging and intrinsically motivating. Recent research has also suggested that aspects of instructional design typically associated with cognition (e.g., formatting and sequencing of instructional presentations) may be closely related to affective states such as boredom (Kalyuga 2011). However, a deeper understanding of state boredom as a construct is necessary to inform more specific and pragmatic pedagogical strategies.

## Defining state boredom

Throughout the literature, there are competing approaches for defining state boredom, with many researchers noting the lack of an agreed-upon definition (see Belton and Priyadharshini 2007). As a result, assessments of state boredom have been similarly inconsistent, leading to decreased comparability among research studies and diminished generalizability of proposed interventions. In response, three major reviews of the boredom literature (i.e., Smith 1981; Vodanovich 2003; Belton and Priyadharshini 2007) have endeavored to synthesize the extant findings and arrive at a singular, unequivocal definition of boredom and its associated assessment methodology. However, the culminating conclusion across these reviews was that "boredom is an ambiguous concept" (Belton and Priyadharshini 2007, p. 592) that lacks a common definition. Consequently, consistently applicable assessment tools are also elusive, resulting in difficulty developing educational interventions or knowing when such interventions should be applied.

What follows is a comprehensive, systematic cross-disciplinary review of theoretical and empirical investigations of state boredom. Specific emphasis is paid to the dimensions articulated by Russell (1980) and how this work has influenced current definitions of state boredom. Following this review, a definition of state boredom is developed and used to identify empirically sound and technologically driven tools for the measurement and mitigation of state boredom in educational settings. Finally, consequent areas of future inquiry into boredom and its measurement are identified.

## Search methodology

In an effort to conduct a thorough investigation across disciplines, an extensive search of the literature was conducted. Specifically, an initial search using the term "boredom" through Google Scholar yielded 109,000 hits, including dissertations, reviews, theoretical, and empirical articles. Titles and abstracts were reviewed, and the first 1,000 most relevant manuscripts were acquired and carefully examined. Those that did not provide a definition of boredom, including studies that provided only antecedents or correlated behaviors ($n$=828), that solely investigated trait boredom (boredom proneness (BP); $n$=111), or that were unable to be retrieved ($n$=21) were excluded, leaving 40 remaining manuscripts. These manuscripts were then back-searched, yielding a total of 163 articles. Of the articles identified by the back-search, those that failed to provide an explicit definition ($n$=40), were duplicates of those already retrieved ($n$=76) or were unable to be retrieved ($n$=25) were excluded, leaving 22 remaining manuscripts. A parallel search was also conducted using PsycInfo, yielding 1,299 hits. Those that were repeated from the Google Scholar search ($n$= 186), did not provide a definition of boredom, including studies that provided only antecedents or correlated behaviors ($n$=601), that investigated BP ($n$=413), or that were in a different language ($n$=79) were excluded, leaving 20 remaining manuscripts. In addition to these searches, the lead author's personal collection of boredom manuscripts ($n$=149) were reviewed, yielding 18 manuscripts that specifically provided a definition of boredom. Four boredom investigators were also contacted and asked for nine manuscripts that we were unable to obtain as well as any additional manuscripts they might recommend; all of these researchers responded. From these personal communications, nine additional boredom articles were retrieved. Thus, in the final tables, only studies that specifically define state boredom are included, yielding 109 studies (see Fig. 1 and Tables 1, 2, 3 and 4).

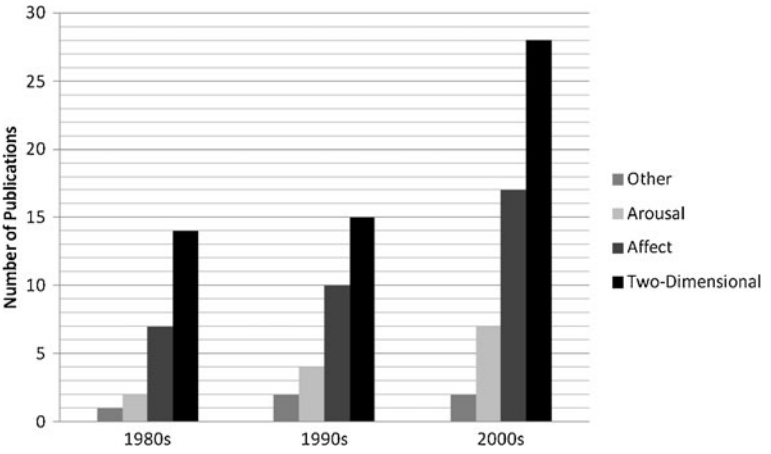


**Fig. 1** Graph of the distribution of boredom publications across decades, separated by definitional category

## Contemporary Definitions of Boredom

In an attempt to validate a theoretical position for the definition of boredom, Russell (1980) asserted that boredom involves both unpleasant emotions as well as low arousal. This conceptualization suggested that boredom is actually a multi-dimensional construct that can be measured and addressed empirically. In Russell's study, participants were asked to rate 28 different emotions on scales of valence, defined as the level of pleasantness of the emotion, and arousal, defined as the level of behavioral activation created by the emotion. Using these data, Russell developed a circular theoretical representation of emotions, or the *Circumplex Model*, whereby each emotion was identified as a theoretically measureable grid coordinate. Boredom was defined as the 240° location, or $-x$ (valence) and $-y$ (arousal). It is upon this theoretical definition that much of the contemporary research is based (Kaiser and Oertel 2006; D'Mello *et al*. 2007; Pekrun *et al*. 2010; Posner *et al*. 2009).

A review of the contemporary literature suggests that the majority of research supports one or both dimensions described by Russell (1980). That is, definitions of state boredom generally fall into categories involving subjective emotional experience, arousal (i.e., behavioral activation), or both (i.e., the two-dimensional approach; see Fig. 1). Each of these viewpoints is described in depth below (see Tables 2 and 3), and those researchers who identified boredom as a composite of both dimensions are described in Table 4.

**Table 1** Boredom reviews

| Citation | Definition | Theory/empirical definition | Theory/empirical article |
|---|---|---|---|
| Belton and Priyadharshini (2007) | Indefinable feeling that evokes discomfort, resentment, guilt, and bafflement—sometimes pleasure | Review | Review |
| Vodanovich (2003) | No coherent, universally accepted definition of boredom | Review | Review |
| Smith (1981) | Feeling, drive, or conflict | Review | Review |

**Table 2** Boredom definitions: low arousal

| Citation | Definition | Theory/empirical definition | Theory/ empirical article | Assessment method |
|---|---|---|---|---|
| Anderson (2007) | Under-stimulation and disconnection | Theory | Theory | |
| Svendsen (2005) | Desire for sensory stimuli | Empirical | Theory | |
| Becker *et al*. (2004) | Mental state of inactivity | Theoretical | Theory | |
| Passik *et al*. (2003) | Disengagement | Theory | Empirical | Multiple self-report measures |
| Mastro *et al*. (2002) | Acute under-stimulation | Bryant and Zillman (1984) | Empirical | Self-report and performance |
| Kass *et al*. (2001a, b), Bargdill (1998), and Thackray (1981) | Monotony | Theory | Empirical | Self-report |
| Caldwell *et al*. (1999) | Lack of control and intrinsic motivation | Theory | Empirical | Single-item self-report |
| Darden and Marks (1999) and Grose (1989) | Lack of drama, repetitive, uninteresting roles and lack of options | Empirical | Empirical | Self-report |
| Scerbo and Holcomb (1993) | Prolonged exposure to monotony, when optimal levels of arousal cannot be maintained | Based on O'Hanlon (1981) | Theory | Self-report |

## Boredom as unpleasant subjective emotional experiences

Subjective emotional experiences are responses to stimuli (Zajonc 1980) that may be influenced by cognition or prior experience (Brewin 1989). The extent to which individuals can adjust or regulate their emotional responses may be further moderated by temperament, personal experiences, and social interactions (Griffiths 1997; Thompson 1994). Definitions of state boredom often include subjective unpleasant emotional experiences. Specifically, the current investigation identified 36 manuscripts that broadly define boredom as perceptions of a sub-optimal challenge, dissatisfaction, or meaninglessness.

Studies in this category have been consistently conducted across all three decades searched, with the majority being empirical (62%). Self-report measures were typically utilized to assess state boredom, and such research has suggested that state boredom is conceptually distinct from feelings of depression, anxiety, frustration, and perceptions of life meaning (Fahlman *et al*. 2009). In fact, recent work on sequences of emotions has suggested that frustration can either be an antecedent or a consequence of boredom (D'Mello and Graesser 2010; D'Mello *et al*. 2007).

There is also significant overlap between state boredom and a variety of emotional experiences, including anxiety (Rani *et al*. 2005), dissatisfaction (Fahlman *et al*. 2009;

**Table 3** Boredom definitions: unpleasant emotion

| Citation | Definition | Theory/empirical definition | Theory/ empirical article | Assessment method |
|---|---|---|---|---|
| Barkoukis (2010), Lin *et al*. (2009), Assor and Kaplan (2001), and Iso-Ahola and Weissenger (1987, 1990) | Negative affective state | Theory | Empirical | Self-report |
| Nett *et al*. (2011) | Unpleasant and undesired emotion | Mikulas and Vodanovich (1993) | Empirical | Self-report |
| Auerbuch (2009) | Unpleasant and transient affective state; lack of interest or difficulty concentrating | Game (2007) | Empirical | Self-report |
| Fahlman *et al*. (2009) | Dissatisfaction and disengagement | Theoretical | Empirical | Multiple self-report measures |
| Aho (2007), Alves (2003), Barbalet (1999), Conrad (1997), and Fisher (1993) | Loss of interest | Theory | Theory | Self-report |
| Barnett (2005) | Unfilled free time | Empirical | Empirical | Self-report |
| Rani *et al*. (2005) and Kanevsky and Keighley (2003) | Sub-optimal challenge | Empirical | Empirical | Physiological, self-report, and performance |
| Anderson (2004) | Boredom emerges from a breakdown, or incapacity, in the framing action of habit | Theory | Theory | |
| Binnema (2004) and Strong *et al*. (2003) | Lack of meaning | Theory | Theory | |
| Jagacinski and Duda (2001) | Lacking interest or enjoyment | Theory | Empirical | Self-report |
| Bargdill (2000a, b) | Repressed drives | Based on Fenichel (1953) | Empirical | Self-report |
| Vodanovich and Rupp (1999) | Motivational and time usage deficits, correlated with procrastination | Based on Farmer and Sundberg (1986) | Empirical | Self-report |
| Chen (1998) | resistance due to lack of control in the learning process | Empirical | Empirical | Brown's Q methodology |

**Table 3** (continued)

| Citation | Definition | Theory/empirical definition | Theory/ empirical article | Assessment method |
|---|---|---|---|---|
| Dyer-Smith and Wesson (1997) | The affect experienced due to a mismatch in the allocation of mental resources | Empirical | Empirical | Observational |
| Green-Demers (1997) | Aversive and counter-productive experience | Theory | Empirical | Self-report |
| Weinstein *et al.* (1995) | Purposelessness | Frankl (1963, 1978) | Empirical | Self-report |
| Geller (1994) | Loss of interest | Based on Greenson (1953) | Theory | |
| Freeman (1993) | Negative emotion and frustration | Theory | Theory | |
| Iso-Ahola and Crowley (1991) | Sub-optimal arousal due to insufficient leisure experiences | Empirical, from Iso-Ahola and Weissenger (1987, 1990) | Empirical | Self-report |
| Johnson-Laird and Oatley (1989) | Depression due to a lack of goals | Based on Fehr and Russell's corpus | Theory | |
| Damrad-Frye and Laird (1989) | Self-awareness of inattention | Empirical | Empirical | Self-report |
| de Chenne (1988) | Dissatisfaction and repressed goals | Based on Modified Activation Model by Maddi (1980) | Theory | |
| Hillard (1988) | Muteness and frustration | Empirical | Theory | |
| Gabriel (1988) | Unspecific longing, disinclination to action, passive expectant attitude, distorted sense of time, and absence of fantasy | Based on Greenson (1953) | Empirical | Self-report |
| Moore (1987) | Lack of motivation | Theory | Theory | |

Barbalet 1999), depression (Strong *et al.* 2003; Johnson-Laird and Oatley 1989), repression (Bargdill 2000a; de Chenne 1988) frustration (Freeman 1993; Hillard 1988), meaninglessness (Binnema 2004), unpleasantness (Green-Demers 1997), and discomfort (Gabriel 1988; see Table 4 for a full review).

Much of the current body of literature in this subcategory attempts to identify additional correlates, moderators, or mediators of boredom. Contributions from this area of research suggest the following conditions and individual differences potentiate states of boredom: giving up life projects (Bargdill 2000b); external orientation, frustrated needs, low skill level, high customary needs (de Chenne 1988); low leisure attitude, leisure repertoire, self-

**Table 4** Boredom definitions: two dimensional

| Citation | Definition | Theory/empirical definition | Theory/empirical article | Assessment method |
|---|---|---|---|---|
| Acee *et al*. (2010), Baker *et al*. (2010), Pekrun *et al*. (2009, 2006), Artino (2008), Goetz *et al*. (2007), Goetz *et al*. (2006, Nett *et al*. (2011), Pekrun *et al*. (2006, 2010, 2011), and Kaiser and Oertel (2006) | Negative-deactivating emotion | Based on Russell (1980) | Empirical | S-R and physiological |
| Azizi (2010), Author (2008), D'Mello *et al*. (2007), Jurich (2004), and Wallace *et al*. (2002) | Low arousal and dissatisfaction | Vodanovich (1993) | Theory | |
| D'Mello and Graesser (2009), D'Mello *et al*. (2008, 2011), Craig *et al*. (2008), Danckert and Allman (2005), and Graesser *et al*. (2006) | Weary or restless due to a lack of interest | Theoretical | Empirical | Observational |
| Posner *et al*. (2009) | Displeasure and deactivation | Based on Russell (1980) | Empirical | Neuro-physiological |
| Chanel *et al*. (2008) | Negative calm | Theory | Empirical | S-R and physiological |
| Czikszentmihalyi (2000) | Tedium, repetitive dullness, and lack of meaning | Theory | Theory | |
| Craig *et al*. (2004), Larson (1985, 1990) | Uninterested and unmotivated | Based on Kort *et al*. (2001) | Empirical | Performance and affective coding |
| Todman (2003) | Unpleasant state and environmental sameness | Theory | Empirical | Case studies |
| Pekrun *et al*. (2002) | Negative emotion caused by mismatched challenge | Empirical | Empirical | Self-report |
| Jarvis and Seifert (2002) | Disengagement and negative attitude/behavior | Empirical | Empirical | Self-report and interview |
| Kapoor *et al*. (2001) | Negative affect and unlearning | Based on Kort *et al*. (2001) | Theory | |
| Fisher (1998) | Unpleasantness and low concentration | Based on Fisher (1993) | Empirical | Self-report |
| Green-Demers *et al*. (1998) | Unpleasantness due to prolonged exposure to monotonous stimulation | Mikulas and Vodanovich (1993) and O'Hanlon (1981) | Empirical | Self-report |
| Rule (1998) | Between temporary monotony and ongoing depression; helplessness | Theory | Theory | |
| Scerbo (1998) | Low arousal, repressed drives, and repetitiveness | Based on Perkins and Hill 1985 | Theory | |
| Farnworth (1998) | Lack of challenge, under/over arousal, meaninglessness, unmet and needs | Theory | Theory | |

**Table 4** (continued)

| Citation | Definition | Theory/empirical definition | Theory/empirical article | Assessment method |
|---|---|---|---|---|
| Conrad (1997) and Fisher (1993) | Unpleasant and low concentration | Based on Fisher (1993) | Theory | |
| Shaw *et al.* (1996) and Mikulas and Vodanovich (1993) | Under-stimulation, under-arousal, and dissatisfaction | Based on Brissett and Snow (1993), Larson and Richards (1991), and Mikulas and Vodanovich (1993) | Empirical | Single-item S-R |
| Spacks (1995) | Need for activity, lack of impulse, and unpleasurable | Empirical | Theory | |
| Phillips (1993) | Restlessness and desire | Theory | Theory | |
| Sundberg and Staat (1992), Sundberg *et al.* (1991), Sundberg and Latkin (1988), Sundberg and Bisno (1983), and Hamilton (1981) | Internal state, monotony, meaninglessness, and lack of connection/interest | Theoretical | Empirical | Self-report |
| Larson and Richards (1991) | Under-arousal related to habituated tasks; frustration and forced effort | Empirical; from Smith (1981) and Thackray (1981) | Empirical | Self-report |
| Rohrkemper and Corno (1988) | The stress of tedium | Theory | Theory | |
| Leary *et al.* (1986) | Affective consequences of effortful maintenance of attention | Based on Hamilton (1981) and Hamilton *et al.* (1984) | Empirical | Self-report and behavior |
| Petersen (1986) | Negative experience caused by repetitive conditions leading to desire for change | Based on Thackray (1981) | Empirical | Self-report, performance, and physiological |
| Perkins and Hill (1985) | Cognition (subjective monotony) and affect (frustration) | Empirical | Empirical | Self-report |
| Stuckey (1985), Bryant and Zillman (1984), and Perkins (1981) | Negative affect and low arousal | Theory | Empirical | Self-report |
| Davies *et al.* (1983) | Emotional response to monotonous situation | Theory | Theory | |
| Kopp (1982) | Lack of arousal, uninteresting/ unpleasant task, and sacrifice of self-determination | Robinson (1975) | Theory | |
| Russell (1980) | Low arousal and displeasure | Empirical | Empirical | Self-report |

motivation, awareness of the psychological value of leisure time (Iso-Ahola and Weissenger 1987); and a reduction in control, choice, challenge, complexity, and caring in learning (Kanevsky and Keighley 2003; Chen 1998).

The literature also suggests that the interaction of individual characteristics with such stimuli further promotes boredom. For example, under low anxiety conditions, a perceived increase in challenge mitigates boredom and enhances performance (Rani *et al*. 2005). Similarly, high work contributions (i.e., significant efforts in the workplace) and high leisure constraints (i.e., limitations during leisure time) lead to reduced boredom (Iso-Ahola and Weissenger 1987, 1990). Together, these studies imply that low arousal across tasks can produce unpleasant emotional experiences and lead to increased feelings of boredom during these tasks. In fact, research conducted in this category generally implies a need for both low arousal and subjective emotional experience. However, definitions of state boredom that focus exclusively on unpleasant emotions generally regard low arousal as an indirect cause of boredom, and definitions of boredom as unpleasant emotional experience focus on the *negative interpretation* of states (such as low arousal).

## Boredom as low arousal

State arousal, the second dimension described by Russell (1980), derives from the interaction of behavioral activation and the task/environment. Despite the debates regarding the interaction of performance and arousal, it is generally assumed that there exists an optimal level of arousal during which individuals maximally learn or perform (i.e., Yerkes and Dodson's 1908 law; see Hebb 1955). When arousal is below this optimal level, it may be interpreted as boredom. Specifically, the contemporary literature finds that individuals experiencing boredom frequently report feeling under-aroused, uninterested, and weary (see Table 3 for a full review); this is in contrast to much of the research conducted prior to 1981 (see Smith 1981).

As with studies hypothesizing state boredom as a unpleasant emotional experience, the literature examining arousal levels most commonly relied on self-report measures (e.g., Mastro *et al*. 2002; Caldwell *et al*. 1999; Darden and Marks 1999; Bargdill 1998; Scerbo and Holcomb 1993). Though the ability of subjective measures to validly assess arousal is beyond the scope of this review, it should be noted that objective measures of arousal, such as physiological sensors, may provide a direct pipeline that is unmediated by subjective perception or reporting bias.

Researchers who utilized low arousal to define boredom found several trends. Specifically, the longer individuals spent on a monotonous task, the more likely they were to experience boredom (Scerbo and Holcomb 1993); also, boredom may be produced when adolescents are forced into activities (Caldwell *et al*. 1999). Finally, boredom was more pronounced when individuals were alone rather than in groups (Darden and Marks 1999). Thus, based on theoretical definitions alone, stimuli suggested to elicit low arousal and lead to boredom include those described as repetitive, monotonous, and lacking in drama or control. Although empirical validation is needed, the findings provide important implications for educational practice.

## Boredom as unpleasant emotional experiences and low arousal

Proponents of the two-dimensional approach suggest that state boredom is an interaction of both an unpleasant emotional experience and low arousal. As such, both

one's physiological response to stimuli as well as the subjective interpretation of one's physiological response are essential components. Thus, this research defines boredom as a psychological state of dissatisfaction, frustration, or negativity that occurs concurrently with the neurological state of low arousal during uninteresting, monotonous, or repetitive tasks/stimuli. However, the causal direction between these two states remains unclear.

The most common method used to assess boredom was a combination of performance and physiological data. Results from initial studies suggest strong support for the two-dimensional approach (Bryant and Zillman 1984; Chanel *et al*. 2008; Kaiser and Oertel 2006; Petersen 1986; Posner *et al*. 2009). Other studies aimed to debunk earlier claims that boredom is defined solely by meaninglessness (Perkins and Hill 1985) or that it can be distinguished from disliked activities by the level of frustration experienced (Perkins and Hill 1985). Still others attempted articulate correlations, such as the connection between boredom and inappropriate levels of challenge (Pekrun *et al*. 2002; Jarvis and Seifert 2002).

Finally, those researchers who defined state boredom as a two-dimensional construct focused mainly on learning, finding that state boredom significantly and negatively impacts the learning process (e.g., Craig *et al*. 2004; Larson 1990). Further, investigators found that state boredom increases when the perceived skill of the individual exceeds the level of task challenge (Chanel *et al*. 2008; Pekrun *et al*. 2002; Jarvis and Seifert 2002) or little choice is provided to the learner during the learning process (Shaw *et al*. 1996).

## Assessment of Boredom

Over the last three decades, a large number of measurement tools have been utilized to assess boredom, and can be generally categorized into three meaningful types: self-report, observational, and physiological (see Fig. 2).

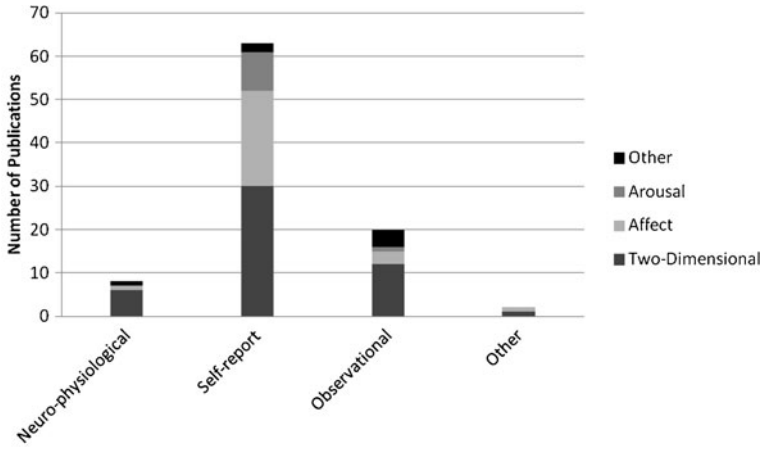


**Fig. 2** Distribution of measure use across boredom definition categories; studies that used multiple measures were included in each relevant measurement group

### Self-report

The vast majority of studies utilized self-report measures in some capacity. Some used single-item self-report measures that asked participants if they were feeling bored at a given point in time (e.g., Shaw *et al*. 1996; Caldwell *et al*. 1999; Darden and Marks 1999). Some utilized validated and normed self-report measures that targeted a specific type of boredom (Ragheb and Merydith 2001; Watt and Ewing 1996; Iso-Ahola and Weissenger 1990; Lee 1986; Hamilton *et al.* 1984; Grubb 1975). Still others used structured or semi-structured interviews (e.g., Jarvis and Seifert 2002) to determine when and how often boredom was experienced.

A major challenge with self-report measures is that individuals, in many situations, cannot perceive their own emotions (Mauss and Robinson 2009). In other cases, individuals may misattribute other states or feelings to boredom (Damrad-Frye and Laird 1989; Caldwell *et al*. 1999; Fisher 1998). For example, low arousal could be confounded by fatigue and distraction; that is, it could be difficult for individuals and researchers alike to determine if a person is bored or if he or she is simply tired and/or inattentive. Individuals may also misattribute feelings of sadness, frustration, and anger, further complicating the validity of self-report measures. However, in the case of more rigorously tested assessments, multiple questions help distinguish between feelings of boredom and other experiences or feelings, which reduces the likelihood of misattribution or confusion. Specific scales noted in this review include: Academic Boredom Scale 10 (Acee *et al*. 2010); Job Boredom (Grubb 1975; Lee 1986); Boredom Coping (Hamilton *et al.* 1984); Leisure Boredom (Iso-Ahola and Weissenger 1990); Free Time Boredom (Ragheb and Merydith 2001); Sexual Boredom (Watt and Ewing 1996); and the Purposelessness, Understimulation, and Boredom scale (Passik *et al*. 2003).

Self-report measures likely provide the most practical approach for assessing state boredom in educational settings. Specifically, subjective measures of boredom provide educators with a relatively quick and easy approach toward identifying learning material that is most strongly associated with feelings of boredom. These measures can also help determine the optimal pace of instruction and specific instructional strategies appropriate for mitigating state boredom. However, given their questionable validity due to misattribution, alternative methods of assessment may be necessary to better identify states of boredom.

### Observational

Recently, various observational methods of assessing boredom have become increasingly popular (e.g., Cooper *et al*. 2011; Craig *et al*. 2004; D'Mello *et al*. 2007; D'Mello *et al*. 2011; Mastro *et al*. 2002; Rani *et al*. 2005). Since boredom is expected to most meaningfully impact occupational performance and knowledge acquisition, observational assessments are seen most often in workplace (Kass *et al.* 2001a) and education literatures (D'Mello *et al*. 2007; Craig *et al*. 2004; Petersen 1986; Rani *et al*. 2005).

Observational techniques can either be performed by human observers or by computer-based assessment approaches. For example, experiments have often used human raters to distinguish between boredom and other related emotional states (e.g., confusion and frustration) through facial expression coding during learning. These studies typically involve multiple trained raters watching videos of participants completing a learning session (Craig *et al*. 2004; Graesser *et al*. 2006). The raters are asked to code the facial expressions exhibited by the participant at varying time intervals. In a study by Graesser *et al.* (2007), participants also watched videos of themselves and were asked to code their own affective states. These forms of retrospective coding can be inaccurate and unreliable, as it

is difficult to assess the affective states of others, as well as ourselves (Afzal and Robinson 2009; Forbes-Riley *et al.* 2011).

Recent research has also focused on ways in which emotional states can be detected through the use of computer-based technology and typically involve the use of intelligent tutoring systems (Calvo and D'Mello 2010). This work often involves using computer software to analyze various behavior characteristics associated with boredom, including dialogue, facial expressions, and body posture (D'Mello *et al*. 2011). Some instructional systems even have the capability of assessing and distinguishing between affective states in real time and dynamically providing motivational support intended to regulate these emotions (Azevedo and Strain 2011; Chauncey and Azevedo 2010).

Research on the assessment of boredom using observational techniques is still in its infancy; however, significant advances have been made in recent years. One of the most promising lines of research in this area is the use of computer-based assessments. These systems are more reliable, can incorporate multiple measures, and perhaps most importantly, offer the ability for real-time assessment. Additionally, as the development of such systems matures and different emotional states, such as boredom, can be better distinguished, real-time mitigation strategies can then be applied to target the regulation of specific emotions related to learning.

### Physiological

The use of physiological measures for assessing boredom has also grown in recent years (Calvo and D'Mello 2010; Gross 2007; Koole 2009). These measures are often more intrusive, and typically involve sensor being placed on an individual. Specifically, the use of electroencephalographs (EEG), galvanic skin response (GSR), electromyography, and eye tracking have been used to assess emotional states during learning (Cooper *et al*. 2011; Pour *et al*. 2010). Physiological assessments enable the accurate, objective collection of real-time data. These data allow more precise, effective, and efficient interventions to be provided immediately. However, in their current state, they lack practicality in the classroom environment as they are costly, intrusive, cumbersome, and time-consuming. Though not a new concept (e.g., Barmack 1937; 1939a; b), advances in neurological and physiological technology have recently allowed researchers to more accurately and easily validate earlier-developed theoretical models of state boredom and utilize those initial theories to develop more objective measures of state boredom.

In the recent literature, an important observable trend is the growing emphasis on developing objective approaches toward assessing state boredom. Over the last three decades, the literature in this area has progressed from theoretical models (Russell's Circumplex Model; Kort *et al.* 2001 affective model for learning), to using observational ratings of individual's emotions during learning (D'Mello *et al.* 2007; Graesser *et al*. 2006), to confirmatory analyses of these models using physiological information (Posner *et al*. 2009; Chanel *et al*. 2008; Kaiser and Oertel 2006; Petersen 1986; Bryant and Zillman 1984).

The most recent studies focus on identifying objective measurements of boredom (Posner *et al*. 2009) while simultaneously attempting to validate the accuracy of those measures (Chanel *et al*. 2008). It is important to note that objective measures alone are not sufficient for the assessment of state boredom, according to the two-dimensional approach. Rather, these measures should be paired with subjective measures of emotion in order to obtain a comprehensive assessment.

Many recent examples of neuro-physiological state boredom studies can be found. For instance, Posner *et al*. (2009) used functional magnetic resonance imaging, blood oxygen level dependent, and self-report measures to determine the legitimacy of the Circumplex Model

(Russell 1980). Despite a low sample size ($n$=10), the authors were able to show significant support for this earlier-developed theoretical model. Specifically, they found that the two dimensions identified by Russell, i.e., valence and arousal, were definable and measureable using neuro-physiological markers. In Posner *et al.*'s study, boredom was defined as displeasure and deactivation, just as Russell originally theorized. Thus, while these assessment methods may not yet be pragmatic for use in the classroom, their use for validating the definition and other assessments make them worth consideration and use in research.

Chanel *et al*. (2008) investigated state boredom using Tetris as a stimulus. Participants were required to play three levels of the game that were lower than, equal to, or higher than their demonstrated skill level. During their play time, participants' physiological data were examined to detect emotions. Specifically, GSR was measured. Additionally, a plethysmograph device was used to measure relative blood pressure, a respiration belt measured abdomen extension, a temperature sensor measured palmar changes in temperature, and an EEG was used to measure engagement. Finally, participants completed a self-report measure (30 emotion-related questions rated on a seven-point Likert scale) following each game played. Results indicated that when repeatedly playing the same level of difficulty (monotony or lack of challenge), participants reported higher levels of boredom, defined as unpleasant yet calm emotions. Neuro-physiological markers further confirmed this finding and reported an accuracy level of 72.5%.

The findings of Posner *et al*. (2009) and Chanel *et al*. (2008) support the use of contemporary physiological assessment tools to objectively, and in real time, measure feelings of boredom. Kaiser and Oertel (2006) applied these concepts to learning, aiming to utilize the detection of emotions in real time to drive instructional intervention. However, though they report being able to reliably detect learners' emotions during instruction, they were unable to positively affect learning via boredom interventions. As Kaiser and Oertel's (2006) study illustrates, more work is needed to address the specific algorithms for generalizing markers of boredom, as well as using those markers to predict and mitigate state boredom's detrimental impact on learning or performance.

Until minimally invasive measures suitable for the classroom setting are developed, lab-based experimentation that includes physiological sensors for assessing state boredom can be used to investigate its causes and possible mitigation strategies. For instance, this research can be used to identify learning environments that promote low-arousal states in students and inform the timing of mitigation strategies. Additionally, the integration of physiological, observational, and self-report measures will allow for a more valid measure of state boredom by accounting for the two-dimensional nature of the construct.

## Conclusions

### State boredom definition

Based on this review, we suggest that state boredom includes both the subjective perception of unpleasant emotions and the objective assessment of low arousal; that is:

> State boredom occurs when an individual experiences *both* the (objective) neurological state of low arousal *and* the (subjective) psychological state of dissatisfaction, frustration, or disinterest in response to the low arousal.

Whereas much of the literature discussed in this review focused upon only one aspect of this construct, empirical evidence, including recent physiological investigations, more

frequently points to the two-dimensional approach. Continued research to confirm this finding is warranted. However, with a more refined definition, researchers may be able to better identify the antecedents of state boredom and methods to combat its impact in educational settings.

## Recommendations

### Assessments

Given the support for a two-dimensional approach to state boredom, it is necessary to assess both components. In other words, comprehensive assessments during both experimental and naturalistic (e.g., classroom) settings should determine both low arousal and unpleasant emotions in order to distinguish between boredom and other constructs (e.g., fatigue). First, subjective measurements, such as self-report surveys, should be used to obtain emotional experiences, with a specific focus on perceived challenge, feelings of monotony, and perceived personal relevancy. Observational methods of assessment balance objectivity and efficiency in measuring state boredom. Specifically, technology-based observational methods that can detect affective states through various indicators (e.g., facial recognition, body language, and conversational cues) have the potential to not only assess, but also provide mitigation strategies in real time. This research is currently in its nascent stage; however, the use of affective-based intelligent tutoring for regulating emotions related to learning has already produced promising results (e.g., D'Mello *et al*. 2011). Further work is needed to identify technology-based assessment and mitigation strategies that target individual academic emotions such as boredom. Finally, physiological measures may also provide insight into the causes and potential mitigation strategies related to state boredom. From a practicality standpoint, many of these measures may be unsuitable for use in the classroom at this point; however, may still be useful tools for laboratory-based experimentation. Collectively, the current state of the literature suggests that it is necessary to incorporate both subjective (e.g., self-report) and objective (e.g., observational and physiological) measures to fully assess state boredom. Using a combination of these methods will better prepare educators to select appropriate mitigation strategies.

### Mitigating state boredom

Effectively mitigating state boredom in educational settings involves first identifying its situational antecedents, then considering their impact on both subjective emotional experiences and arousal, and finally selecting and applying appropriate mitigation strategies. The antecedents associated with producing unpleasant emotions among students include perceiving a task as meaningless, not being provided with direction or adequate resources, being confined to restrictive circumstances, having little control during the learning process, or having a preference for a different task. Furthermore, tasks that include abstract concepts, are repetitive or monotonous, lack excitement, are not at the appropriate difficulty level, lack momentum or flow, or are void of clear goals or focus typically result in students experiencing low arousal (see Table 5).

*Unpleasant emotional experiences* The literature offers several strategies for mitigating each of the situational factors associated with unpleasant emotions. For example, in order to avoid students perceiving a task as meaningless, the instructor can present material in such a way that is relevant and meaningful to students (Kinchin and O'Sullivan 2003; Moore

**Table 5** State boredom situational factors and mitigation strategies

| Dimension | Situational factor | Mitigation strategy | Citations |
|---|---|---|---|
| Unpleasant emotions | Perceiving a task as meaningless | Present information in a relevant and meaningful context | Kinchin and O'Sullivan (2003), Moore (1987), and White 2007) |
| | A lack of direction or adequate resources | Provide guidance throughout the learning process | Mayer (2004) |
| | Being confined to restrictive circumstances | Encourage student autonomy and provide options | Azevedo and Strain (2011), Joussemet *et al.* (2004), and Kinchin and O'Sullivan (2003) |
| | Having little power or control during the learning process | | |
| | Preferring a different task | Discuss comparative value of two activities | Azevedo and Strain (2011) |
| Low arousal | Abstract concepts or tasks | Provide concrete examples and analogies | Brown (1992) and Newby and Stepich (1987) |
| | Repetitive or monotonous tasks | Change tasks; provide novelty, surprise, or suspense; change pace; and collaborative learning | Kopp (1982), Moore (1987), and White (2007) |
| | Tasks devoid of excitement | | |
| | Inappropriate difficulty level | Adapt instruction by considering students' existing knowledge | Azevedo and Strain (2011) and Kalyuga (2007) |
| | Tasks lacking clear goals or focus | Promote a mastery goal orientation and reorient values | Azevedo and Strain (2011) and Pekrun *et al.* (2006) |

1987; White 2007; see Table 5). Specifically, this may include utilizing concrete examples and analogies, current events, stories, and case studies within a lesson. Another situational factor associated with unpleasant emotional experiences is not providing students with adequate instructional guidance or resources. In response, guided instructional techniques can be implemented to provide the appropriate support and resources to students (Mayer 2004) and consequently, help mitigate feelings of negativity or unpleasantness. For example, instead of students becoming frustrated by a lack of guidance, providing explanatory feedback can help students stay on task and direct them toward the learning objectives associated with a classroom lesson. Students can also experience unpleasant emotions when they are confined to restrictive circumstance or have little control over their own learning. To combat this, educators should encourage student autonomy and provide choices to students about their preferred learning environment (Azevedo and Strain 2011; Joussemet *et al.* 2004; Kinchin and O'Sullivan 2003). At the same time, too much autonomy or too many choices can also have negative effects on motivation (Iyengar and Lepper 2000), suggesting that instruction should consist of a balance between direction and autonomy. For example, teachers could allow students to choose their topic for a class project from a small group of options based on their own interests rather than assigning a particular topic or requiring students to come up with a topic completely on their own. Finally, students may become distracted when they prefer a different task than the activity assigned. In this case, it is important for teachers to openly compare the value or importance of the assigned task compared with the students' preferences (Azevedo and Strain 2011). For instance, if students prefer a group activity as opposed to a direct lecture, explaining why the more direct method is necessary may alleviate negative feelings associated with states of boredom.

*Low arousal* Several mitigation strategies within the literature have also been associated with increasing arousal. For example, in learning environments that require explaining abstract concepts, students provided with appropriate concrete examples and analogies can better facilitate understanding (Brown 1992; Newby and Stepich 1987). Tasks that are repetitive, monotonous, or devoid of excitement can also result in low arousal among students. In these situations, teachers can help increase arousal by changing tasks, increasing the pace of instruction, or presenting something novel, surprising, or suspenseful (Kopp 1982; Moore 1987; White 2007). Further, instruction that is not presented at the appropriate difficulty level should be altered to avoid students experiencing low arousal during tasks that are too easy. This can be accomplished by adapting instruction based on students' prior knowledge before beginning a lesson, as well as dynamic adaption based on real-time assessment during a lesson (Kalyuga 2007). Finally, in order for students to be fully engaged in their learning, they should be aware of the learning goals associated with the task. Using strategies to promote a mastery goal orientation will orient students' attention to the material most relevant for achieving those goals (Azevedo and Strain 2011; Pekrun *et al*. 2006). For instance, explicitly stating the goals of a lesson prior to discussing a topic can help focus students' attention on the information necessary for learning without being distracted by extraneous material.

## Limitations and future research recommendations

Given that the educational literature emphasizes the importance of mitigating situational factors engendering state boredom, the impact of trait boredom, or boredom proneness, was beyond the scope of this paper. It should be noted that the propensity of individuals to experience feelings of boredom can undoubtedly affect state boredom, as can a myriad of other dispositional factors.

The focus of future research in this area will likely center on validating the two-dimensional definition of boredom: sub-optimal arousal coupled with unpleasant emotions. Rather than relying solely on self-report measures, it is expected (and recommended) that objective neurophysiological and physiological sensors be incorporated into future assessment and mitigation strategies. Specifically, ongoing research should explore the optimal combination of physiological markers and self-report measures required for accurate assessment, and the use of non-invasive and efficient sensors, such as eye trackers, should be investigated. Further, using the two-dimensional definition, researchers should determine the ability of various assessments to determine the optimal combination of self-report, observational, and possible neurophysiological sensors to most effectively diagnose boredom and identify specific interventions.

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